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Factors Influencing Uptake of Bench Terraces in Kabale District

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Abstract

The study was conducted to identify the factors influencing the uptake of bench terraces in Kabale district specifically, Rubaya Sub County. The study estimated the yields of Irish potatoes and beans among farmers with and without bench terraces, compared the net returns from Irish potatoes and beans among the farmers with and without bench terraces, identified the perception of the farmers on the uptake of bench terraces, and explored the strategies for increasing the uptake of bench terracing in Kabale district.

The study adopted a descriptive research design to collect and analyse both quantitative and qualitative data. A sample size of 134 study units was selected from a target population of 200 study units using purposive and simple random sampling. Data was collected through questionnaires and interviews while data analysis was descriptive, inferential and thematic for qualitative data.

The findings reveal that farms with bench terraces had better crop yields than the farms without bench terraces (for both beans and Irish potatoes). Farmers' net returns from bench terraces outstrip farmers' net returns from farms that are not bench terraced (for both beans and Irish potatoes). Lack of money, awareness, and attitude are the most limiting factors to the uptake of bench terracing and the strategies for uptake were based on government support holistically for development to be realised.

The researcher concludes that bench terraces should be embraced and promoted for better crop yields since it was evidenced by the research findings. The practical implication on this indicated that bench terraces should be promoted by development practitioners as a means of having degraded land rejuvenated into productive and arable land for agriculture.

In recommendation, government should ensure that bench terracing is promoted by putting in place the budgetary allocations in the sector of Agriculture in order to promote growing of common crops like potatoes and beans, it should highly be recommended to spearhead bench terracing in order to increase on production and productivity which in the long run will as well increase on farmers income, the farmers perception on the bench terracing indicated that they were mainly affected by high investments' and thus government should embrace supporting farmers to venture into terracing, it is highly recommended for the government to foster the policy of bench terracing in the aspect of ensuring sustainable land management technologies are taken on by the farmers.

Keywords: Bench terraces; Net returns from crops; Sustainable land management

Introduction

This section of the research looked at the introductory part of the research, background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, scope of the study, significance of the study, conceptual frame work and definition of terms.

Background

Historical Perspective

Terracing steep lands in Africa is an indigenous technology. The same is true of earth bunds, stone lines and vegetative strips. New methods have evolved over the years in response to increasing population and land pressure. Under colonial regimes, large areas of communal lands were compulsorily terraced in the1950s for example in Kenya, Malawi and Zambia through the construction of ridges or bunds. Often rejected immediately after independence such techniques made a come-back in the 1970s having been improved and promoted through projects and or programs (Huggins, C, 2005) [1]. Fanya juu terraces first developed in the 1950s and are currently spreading throughout East Africa. The period of rapid spread occurred during the1970s to 1980s with the advent of the National Soil and Water Conservation Programme (SWC) in Kenya.

In the West African Sahel, contour stone lines and vegetative barriers have been promoted successfully since the 1980s, as water harvesting structures, mainly applied in Terracing systems in steep areas throughout Africa. This has as well been in other technologies like Stone lines on low slopes mainly West Africa (Burkina Faso, Mali, Niger); Earth bunds and ridges mainly in East Africa (Uganda, Kenya) and Southern Africa (Malawi, Zambia,Zimbabwe), Fanya juu mainly in East Africa (Kenya, Tanzania, Uganda)and vegetative strips throughout Africa especially in the more humid zones, (Alobo, et al; 2011) [2].

Land degradation resulting from unsustainable land management practices is a threat to the environment in Sub Saharan Africa and Uganda is not an exceptional. The threat is as well to the livelihoods where the majority of people directly depend on Agricultural production. There is potentially devastating down ward spiral of over exploitation and degradation enhanced by the negative effects of climate change leading in turn to reduce availability of natural resources and declining crop productivity. Because of its adverse agronomic, environmental, social and economic effects, it has attracted considerable attention from scientists and development agencies around the world (FAO 2016) [3]. Land degradation is widely recognized as a problem for agricultural and rural development in many developing countries and this jeopardises food security and increases poverty (Blanco, 2010) [4].

Land degradation is most problematic in highlands and it impairs the capacity of soils to support proper plant growth (Pender et al., 2004) [5]. It is estimated that 95 million hectares of land in eastern and central Africa have reached a state of degradation where only huge investments can make them productive again (Henao&Baanante, 2016).

Land degradation has been one of the major global issues during the past years particularly because of its adverse impacts on agronomic productivity, the environment, food security and the quality of life. The economic impacts of land degradation have been very severe in some parts of Africa, where productivity has declined by 50% (Greiner, et al; 2009) [6]. It has been reported by Lufumpa (2005) that severe land degradation in Sub Saharan Africa has continued to threaten agricultural productivity and thereby undermine efforts to reduce poverty. Kashay, (2011) estimated that land degradation reduces the annual agricultural GDP of Africa by 3%. The population in Sub Saharan Africa is expected to double in the next 50 years, implying that there will be more demand for food (United Nations Population Fund [UNPF], 2007). Thus, unless corrective measures are taken now, there is likely to be a big food crisis in the Sub Saharan Africa region.

Uganda is one of the countries with very high rates of land degradation in Sub Saharan Africa. Land degradation in Uganda is widespread but varies in magnitudes from one part of the country to another depending on farming practices population pressure, vulnerability of the soil to denudation and local relief (MAAIF, 2010) [12]. The worst affected areas are highlands of Kapchorwa, Bukwo, Kween and Mbale in Eastern Uganda, and Kabale and Kisoro in Western Uganda (Ssewanyana,S.,&Kasirye, I. 2010) [14]. About 85% of land degradation in Uganda is accounted for by soil erosion and nutrient depletion (National Environmental Management Authority (NEMA, 2001) 13]. Land degradation is cited in the Agricultural Development Strategy and Investment Plan (ADSIP) of the country as one of the major constraints to increasing agricultural productivity and production (MAAIF, 2010) [12].

In Uganda, detrimental impacts of land degradation are evident both at national and household levels, and some authors have attempted to quantify them. At the national level, the country was estimated to lose 4% to 12% of total GDP because of land degradation impacts (Pender, et al; 2004) [5]. A decade later, the costs of land degradation were estimated to be 6-11% of agricultural GDP annually. In 2003, NEMA estimated the annual cost of soil nutrient loss due primarily to erosion at about United States Dollars (USD) 625 million per year. In2005, NEMA estimated that soil erosion alone accounted for over 80% of the annual cost of environmental degradation, representing as much as USD 300 million per year. Partly because of land degradation, crop yields at farm level are far below the attainable potential demonstrated by the National Agricultural Research Systems (MAAIF, 2010) [12]. The generally poor performance of the agriculture sector has in turn contributed to food insecurity and malnutrition. Indeed, Ssewanyana and Kasirye (2010) reported that 2 in every 3 Ugandans were food insecure.

Land degradation as a result of soil erosion in Rubaya Sub County is as a factor hampering agricultural development and land-based livelihoods. The agricultural sector constitutes an important part of the Ugandan economy and contributes greatly to the country's overall economic growth, (Alobo, 2011) [2].

Sustainable land management is the antidote, helping to increase average productivity, reducing seasonal fluctuations in yields and underpinning diversified production and improved incomes and food security. For most Sub-Saharan African (SSA) countries, agriculture is crucial to achieving broad based pro-poor economic growth and attaining the Millennium Development Goal of halving poverty and hunger by 2015, and continuing to reduce them thereafter (World Bank, 2007). This is because SSA countries heavily depend on agriculture. It is estimated that approximately 70-80% of employment and 40% of the Africa's export earnings are derived from agricultural activities (Food and Agriculture Organization [FAO], 2006; International Monetary Fund [IMF], 2006) [3,19].

In Uganda as well, agriculture is a core sector for economic growth, food security and nutrition, income enhancement, and employment. Although the sector's share in total Gross Domestic Product (GDP) has declined from over 50% in the early 1990s to only 22.5% in 2010/11, agriculture socially remains the most important sector because most Ugandans derive their livelihood from it. In 2009/10, the sector employed 66% (8.8 million) of the working population and contributed approximately 46% of the total export earnings (Ministry of Agriculture, Animal Industry and Fisheries [MAAIF], 2011) [12].

The contribution of agriculture to economic growth in Sub Saharan African (SSA) countries cannot be over emphasized. A well-performing agricultural sector is considered fundamental for Africa's overall economic growth, as well as addressing hunger, poverty, and inequality. The performance of the agriculture sector greatly depends on land productivity. However, in most SSA countries, agricultural productivity and production growth are low mainly because land in many areas is degraded (Association for Strengthening Agricultural Research in Eastern and Central Africa [ASARECA], 2004; Zimmermann et al., 2009) [2,15,16].

In Uganda, technologies have been specifically promoted to help farmers control soil erosion because it is the major form of land degradation in highland areas (NEMA, 2011)[13]. They include: terraces, contours, trenches agro-forestry, and planting of Napier grass along contours and terraces. Ssewanyana,S.,&Kasirye, I. (2010) [14] provided evidence that farmers can increase their farm productivity by up to 5 times upon adoption of soil conservation technologies. Therefore, increasing the adoption of soil conservation technologies by farmers is a positive step towards increasing economic growth, especially in agrarian economies like Uganda.

Conceptual perspective

Bench terraces are commonly developed on steep slopes as a result of constructing cross-slope barriers. A bench terrace is defined by a flat or slightly backward or forward-sloping bed. Stone-faced terrace risers are characteristic of areas where stone is available (for example the Konso terraces in Ethiopia), otherwise the earth risers are protected by grass. Due to the heavy labor input they are usually constructed to support production of high-value crops such as irrigated vegetables and coffee. The design of the benches is usually calculated by a formula that relates their size and spacing to the slope. Bench terraces are rarely excavated and constructed directly, as this is very expensive, (Greiner, 2009) [6].

Earth bunds (sometimes referred to as 'ridges' in Southern Africa) are soil conservation structures that involve construction of an earthen bund along the contour by excavating a channel and creating a small ridge on the downhill side. Usually the earth used to build the bund is taken from both above and below the structure. They is often reinforced by vegetative cover to stabilize the construction. Bunds are gradually built up by annual maintenance and adding soil to the bund. Fanya juu ('do upwards' in Kiswahili) terraces are made by digging ditches and trenches along the contour and throwing the soil uphill to form an embankment, (Sayer, et al; 2013). A small ledge or 'beam' is left between the ditch and the bund to prevent soil sliding back. In semi-arid areas they are normally constructed to harvest and conserve rainfall, whereas in sub-humid zones they may be laterally graded to safely discharge excess runoff. The embankments (risers) are often stabilized with fodder grasses. Fanya juu terraces can develop into bench terraces. In a Fanya chini system ('do downwards' in Kiswahili) soil is piled below a contour trench. These are used to conserve soil and divert water and can be used up to a slope of 35%. Fanya chini involve less labor than Fanya juu, but they do not lead to the formation of a bench terrace over time as quickly as the former. Stone lines and bunds: In areas where stones are plentiful, stone lines are used to create bunds either as a soil conservation measure (on slopes) or for rainwater harvesting (on plains in semi-arid regions). Stones are arranged in lines across the slope to form walls. Where these are used for rainwater harvesting, the permeable walls slow down the runoff, filter it, and spread the water over the field, thus enhancing water infiltration and reducing soil erosion. Furthermore, the line strap fertile soil sediment from the external catchment, (Pender,et al; 2004) [5].

Vegetative strips are the least costly or labor-demanding type of cross-slope barriers. Such strips are a popular and easy way to terrace land, especially in areas with relatively good rainfall. The spacing of the strips depends on the slope of the land. On gentle sloping land, the strips are given a wide spacing (20-30 m),while on steep land the spacing may be as little as 10-15 m. Vegetative strips can also provide fodder for livestock if palatable varieties of grass (or densely spaced bushes) are used, (Bouma, 2008) [8].

In agriculture, a terrace is a leveled section of a hill cultivated area, designed as a method of soil conservation to slow or prevent the rapid surface runoff of irrigation water. Often such land is formed into multiple terraces, giving a stepped appearance. This form of land uses is prevalent in Ghana, and is used for crops requiring a lot of water. Terraces are also easier for both mechanical and manual sowing and harvesting than a steep slope would be. Arguments continue today about whether bench terracing, involving the physical movement of soil into contoured terraces, is best. Some argue that a more passive and slower option, vegetative contour bunds, is more effective and sustainable. Bench terraces tend to be fairly expensive to construct and are labor intensive, (Rurangwa, 2012)[8].

Installation of bench terraces can increase the risks of landslides and the leaching of nutrients if these are not well constructed and maintained. Bench terraces are generally accepted as the ultimate intensity in physical management of soil runoff and water retention management. Bench terraces require deep and fertile soils to justify the amount of time required for construction. Crops may respond poorly for one or more growing seasons on sites where subsoil is excavated during construction. Bench terraces are generally graded backwards or "reverse slope" so that rainfall flows back toward the foot. Rooting depth and available soil moisture is increased, and when properly constructed, there is no net loss in planting surface area. Increased yields and increased growing provides a good solution for Uganda in areas that may be converted, (Sanginga, 2010)[9].

Once bench terraces are built, soil fertility must be restored with the use of manure, lime and phosphorus if yields are to double or triple after some years. Since the risers are almost vertical, only 20 % of the land area cannot be cropped, although it can still produce forage. Terracing, especially bench terracing is generally not carried out as a large-scale operation on public lands. More often, the work is done by small farmers, assisted technically and financially by the government or projects, (Sanginga, 2010)[9].

The argument most often heard against bench terracing is its cost, a conclusion often reached by multiplying the amount of soil to be cut and filled and the resulting work required per hectare by the official daily wage. The result usually shows a cost per hectare which no farmer can afford. However, the fact that farmers in East African Countries have constructed terraces for centuries shows clearly that when population density and intensity of cultivation reach certain thresholds, bench terraces are a workable solution, (Saint-Macary, 2010).

Incentives to farmers may be necessary to accelerate the development of terraces. Furthermore, it is often found that cultivation on terraces is so intensive that a quarter of hectare can generate full-time employment for one person. The construction of the terraces is divided over several years. In order to "create" 0.25 ha of cultivable land, the upland farmer may work one month per year over four years, during periods of low agricultural activity, (Shiferaw, 2009)[10].

Permanent structures of these kinds are effective soil conservation technologies as excessive soil loss and silting up of the fields are reduced. However, high labor intensity, time consuming regular inspections, high consumption of scarce farmland, and the large amounts of construction material required are factors that stop farmers from installing or maintaining terraces.

Statement of the Problem

The innovation of bench terraces one of the technologies for sustainable land management has been promoted by Kigezi Diocese Water and Sanitation programme (KDWSP) under the integrated water resource management (IWRM) project for the past five years in Rubaya Sub County. The land users and land owners in the area were given a diversity of knowledge and the skills of land management and this was geared towards addressing the issues related to land degradation brought about by both human and natural forces, (KDWSP annual report, 2016). Despite the continuous efforts to promote bench terraces for sustainable land management and increasing on crop production and productivity, the uptake of the technology is still low (Kigezi Diocese, 2016). This was based on the statistical figures from the report where out of 5 parishes that Kigezi Diocese Water Sanitation Programme reached out, with 1, 349 farmers only 108 farmers had taken on the venture of terracing their land.

The land users and owners are willing to uptake a technology if it provides higher net returns, lower risk or a combination of both, (Bizoza 2010). It is not clear however, whether these aspects of higher net returns or lower risks are among the factors leading to low adoption rates of the bench terraces technology.There are evident impacts of land degradation and despite the efforts by Government and non-government organizations to promote technologies that improve on land productivity and increase crop production, the uptake of these technologies by farmers has not reached the recommended standards (Bamwerinde, 2008) [11]. This was thus, the basis for the research to explore the factors influencing the uptake of bench terraces, in Kabale district specifically Rubaya Sub County.

Purpose of the study

Explore the factors influencing the uptake of bench terraces technology in Kabale district.

Objectives of the study

- To estimate the crop yields of the common food crops; Irish potatoes and beans among farmers with and without bench terraces in Kabale district
- To compare the net returns of the common food crops; Irish Potatoes and Beans among the farmers with and without bench terraces in Kabale district
- To identify the perceptions of the farmers on the uptake of bench terraces technology in Kabale district.
- To explore the strategies for increasing the uptake of bench terraces technology in Kabale district.

Hypotheses

The research was guided by the hypotheses;

H0: There is no significant difference in crop yields between farmers using bench terraces and those without bench terraces.

H1: There is a significant difference in crop yields between farmers using bench terraces and those without bench terraces.

H0: There is no significant difference in net returns between farmers using the bench terraces and those without bench terraces.

H1: There is a significant difference in net returns between farmers using the bench terraces and those without bench terraces.

Justification of the Study

The low adoption of soil conservation technologies perhaps explains why authors like (Sayer, Kilewe & Hatibu, 2013) have reported that land degradation in Uganda and other countries in eastern and central Africa not only persists, but is steadily increasing. The persistence of land degradation due to soil erosion in Kabale disrtcit and in particular the hilly sub counties like Rubaya sub county is a big challenge to attainment of food security and substantially high incomes, especially among households that solely depend on agriculture. This supported the justification why the research was to be conducted to further find out factors that influence the uptake of bench terraces a technology that works against soil erosion and brings about improvement in land management for increased crop production and productivity.

Scope of the Study

Geographical Scope

On the geographical scope, the study was carried out in Rubaya Sub-county in Kabale district, which is located in the highlands of south western Uganda. This area was chosen because it is hilly and farmers grow Irish potatoes and climbing beans on pieces of land with and without bench terraces.

Content Scope

On the content scope, concentration of the study was on uptake of bench terraces technology in line with the set objectives of the study.

Context Scope

On the context scope the uptake of bench terraces technology was to address the challenges related to land degradation and crop production in the area of study.

Time Scope

The study was to consider an operation period of 2 Calendar years in consideration of the planting seasons for the Irish Potatoes and Beans grown in the area.

Conceptual Framework

The conceptual framework below focused on the factors influencing the uptake of bench terraces technology in Kabale district. Uptake of bench terrace technology was the independent variable and sustainable land management and crop production yields were a dependent variable.

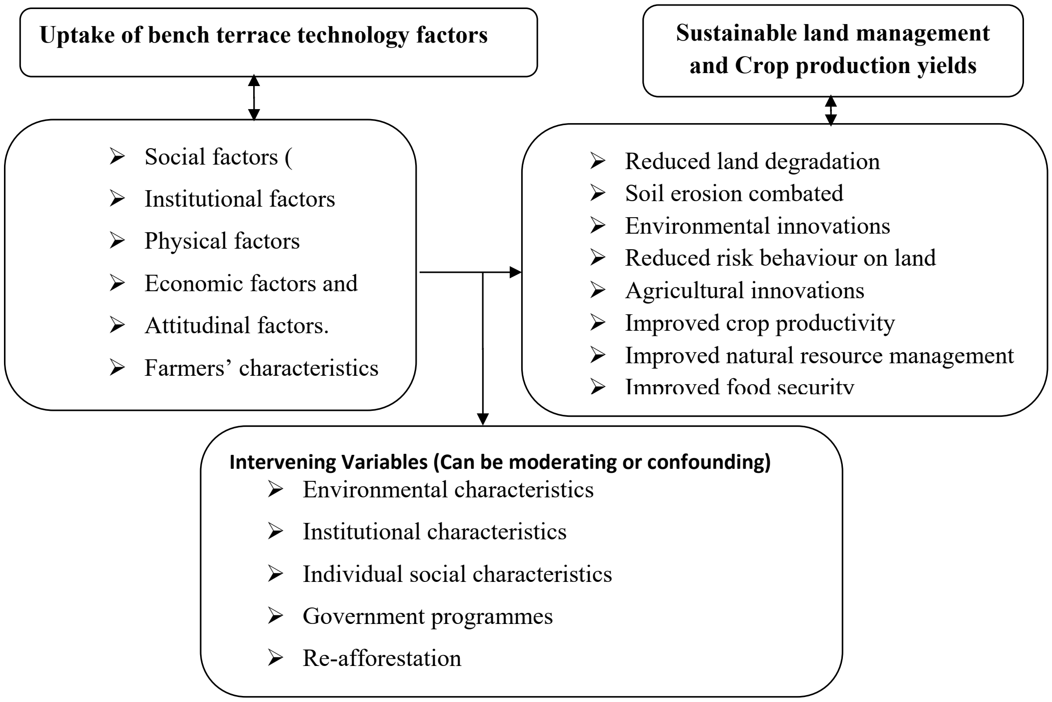


Figure 1: Conceptual framework

Source: Adapted by the researcher based on Pender, et al; 2004) [5]

The figure above is a diagrammatic application of the conceptual framework on bench terrace technology and its impact on sustainable land management that would result into high crop yields. Uptake of bench terrace technologies was influenced by various factors, usually categorized into; farm specific characteristics, technology specific attributes, and farmer's socioeconomic characteristics. Examples of such variables that have been found to influence technology uptake include: farm size, farmer's age, education, social networks, dependency ratio, gender, access to agricultural advice and information, land tenure security, soil fertility, soil type, income, input availability, access to markets, risk aversion behavior, technology awareness, farming experience, adequacy of farm tools, technical and economic feasibility of using the technology, agro-ecological conditions, access to credit and presence of enabling policies (Pender, et al; 2004) [5].

Land management practices comprised a number of key characteristics that would affect their adoption decision at the farm level in one way or another. The literature on the adoption of agricultural technologies, including on sustainable land management (SLM) practices that reduce soil and nutrient loss through degradation, was extensive (Adimassu et al., 2016) [17]. In areas where soil erosion was common, nutrient depletion occurs and this causes the land to become unproductive (Adimassu et al; 2014.; Kassie et al., 2009a) [17,18]. It was also conceptualized that intervening variables comprising of locality environmental characteristics, institutional characteristics, individual social characteristics, government programmes and re-forestation also has an influence on sustainable land management in hilly areas of Rubaya Sub-County.

Significance of the study

To the University; the study would create a benchmark for further research to the users of Bishop Stuart University and other institutions of higher learning as it avails information on bench terrace technology as an innovation for sustainable land management in Kabale District, Uganda Sub-Saharan Africa and World at large.

To the policy makers; the study findings would be beneficial to policy makers especially the Government of Uganda to put forward policies that will greatly enhance sustainable land management with emphasis on bench terracing in hilly areas after obtaining better results from this study. Therefore the research finding was to act as a reference tool for policy makers, other researchers and the target community for further developmental undertakings.

To explore which factors explain the current and future adoption of terraces with close attention to the potential effects of local institutions and farmers capacity to invest in bench terraces in Rubaya Sub-County in Kabale district.

To the researcher; this study enabled the researcher to obtain first-hand information concerning bench terrace technology an innovation for sustainable land management. It was further a benefit to the researcher to obtain a Master's Degree in Agriculture and Rural Innovations of Bishop Stuart University.

Definitions of key terms

Sustainable land management

Sustainable Land Management is defined as knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fiber demands while sustaining ecosystem services and livelihoods (IMF, 2006) [19]. The practices include: Diversified cropping systems (strip cropping and mixed intercropping), Integrated agro-forestry practices with the cropping system and Soil erosion control structures and practices that is contour farming and grass barriers (Roberts *et al*., 2008).

Bench terraces

These are a series of level or virtually level strips running across the slope at vertical intervals, supported by steep banks or risers.

Uptake

This is defined as the degree of use of a new technology in the long-run equilibrium when the farmer has full information about the new technology and its potential.

Land degradation

Land degradation can be defined as the loss of land productivity through one or more processes, such as reduced soil biological diversity and activity, the loss of soil structure, soil removal due to wind and water erosion, acidification, salinization, water logging, soil nutrient mining, and pollution (IMF, 2006) [19].

Land Management

According to Kamau et al; (2014) [20], land management can be defined as the process of managing the use and development (both in urban and rural settings) of land resources. It is the methods used in managing land resources – the 'how' of land use

Literature Review

Introduction

This chapter presented the literature reviewed from different sources like text books, magazines, newspapers, terracing and land management reports, newsletters and previous research dissertations among others. The literature was reviewed objective by objective

Theoretical Review

Theoretical Framework: The Innovation-Diffusion Theory

The innovation-diffusion theory as elaborated by Rogers (1995) [21] provided the theoretical foundation for this study. Rogers (1995) [21] defined diffusion as "the process by which an innovation is communicated through certain channels over time among members of a social system". An innovation, according to Rogers (1995) [21], is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". For the purpose of this study, soil conservation practices such as stone/soil bunds are considered as innovation.

The innovation-diffusion model states that a technology is passed on from its source to end users through a medium of agents and its diffusion in potential users for the most part dependent on the personal attributes of the individual user. The model assumes that the technology in question is appropriate for use unless hindered by the lack of effective communication. According to Rogers (1995) [21], a number of factors act together to influence the diffusion of a certain innovation. The four major factors that influence the diffusion process is the innovation itself, how information about the innovation is communicated, time and the nature of the social system into which the technology is being introduced (Rogers, 1995) [21]. Diffusion/adoption research analyses how these factors and a number of other factors act together to ease or obstruct the progress of the adoption of a specific technology among its final user (Surry, 1995).

Surry (1997) elucidates the four most widely used and closely interrelated concepts of diffusion discussed by Rogers (1995) [21]. These are: Innovation decision process, Individual innovativeness, Rate of adoption and Perceived attributes. Here we will discuss in brief the underlying idea behind each.

Innovation decision process: this model describes diffusion as a process through which an individual passes over time and can be seen as having well-defined stages. Rogers (1995:162) [21] identifies five stages in the innovation-adoption process. The stages are knowledge, persuasion, decision, implementation and confirmation. According to this theory, "potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation and confirm (reaffirm or reject) the decision to adopt the innovation" (Surry, 1997).

Individual Innovativeness: innovativeness as defined by Rogers (1995:22) [21] is "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system". The central point of this concept is that individuals who are predisposed to being innovative will adopt an innovation earlier than those who are less predisposed (Surry, 1997).

Rate of Adoption: this is the third widely applied diffusion concept discussed by Rogers (1983). It signifies the relative speed with which an innovation is adopted by members of a social system (Rogers, 1995:22) [21]. The theory states that innovations are diffused over time in a pattern that seems to be an S-shaped curve. That means an innovation proceed through a period of slow, gradual growth before experiencing a period of relatively rapid growth. After the period of rapid growth, the rate of adoption of the innovation will gradually become stable and decline eventually (Surry, 1997).

Perceived Attributes: the concept of perceived attributes implies that potential adopters evaluate an innovation based on their perception with regard to five attributes of the innovation. The attributes are: Trial ability, observability, Relative advantage, Complexity and Compatibility. The theory argues that an innovation will experience an increased rate of diffusion if potential adopters perceived that the innovation: 1) can be tried on a piecemeal basis before adoption, 2) offers observable results, 3) has an advantage relative to other innovations, 4) is not complex and 5) compatible with the existing practices and values. Rogers (1995:206) [21] further indicates that in addition to these five perceived attributes of an innovation, factors like: the type of innovation-decision, the nature of the social system in which the innovation is diffusing, and the extent of change agents' promotion efforts in diffusing the innovation have an effect on innovation rate of adoption.

The Estimated Yields of Irish Potatoes and Beans among Farmers with and without the Bench Terraces

A study by Amsalu, A. and de Graaff, J. (2007) [48] on land use change in Kabale district revealed that the total size of farmland (fallow and cultivated) only increased significantly in one area, while the expansion of farmland in the upland areas had already stopped by the 1950s, due to the lack of available land. The yields on the farm are as a result of several factors like fallowing which paves way for the soil to rejuvenate. In the areas where grassland, bush land and woodlands were covering important areas in the 1950s, these land use classes were converted into small-scale farmland and planted woodlots. Their findings suggested that farmers tend to expand production first into upland areas and thereafter into the wetlands, possibly because of the significant work involved in draining swamps. Studies of the evolution of land use, the agricultural system and soil degradation were previously conducted in Kabale using remote sensing, household and field surveys, transect (NEMA, 2011)[13] and participatory approaches (Mbabazi *et al*., 2013) [22]. The studies found that since the 1950's, almost all land that had been under pasture or wetlands had been converted to cultivation, and most fields were being managed with only short fallows.

Bamwerinde et al. (2008) [11] in a study on idle land in the densely populated Kigezi highlands of South-western Uganda found that plot abandonment and long fallow was a common problem in the area. This contributes to the specific crop production trends since some of the plots which may be put under fallow will rejuvenate the soil fertility parameters and in the due course improve on the crop productivity. Grisley and Mwesigwa (2005) [23] investigated socioeconomic factors influencing seasonal fallowing in Kigezi highlands and revealed that only 26% of farmers reported cropland under fallow.

Shiferaw, et al; (2009) [10], pointed out that Soil is a vital resource for crop production and so its productive capacity should be maintained through use of appropriate technologies. Through research several land management technologies have been developed to combat effects of land degradation. These technologies include: use of legumes in crop rotation, mulching, terracing, biomass transfer, contour bunds, and agro-forestry. This study focused on soil erosion control technologies because soil erosion is the major form of land degradation in Uganda. The technologies used by farmers around Mt. Elgon to control soil erosion are: contours, terraces, trenches, and agro forestry and Napier grass for stabilizing contours and terraces. These technologies when well addressed contribute greatly to the increased yields because when soil erosion is dealt with the crops planted in the fields will be able to produce averagely for the farmers to benefit from the ventures in Agriculture.

While average potato yields in North America and Western Europe often reach 40 tons per hectare, yields in developing countries are usually below 20 tons per hectare. The national average yields for Kenya has been reported at 7.7 tons per hectare, but this figure has fluctuated consistently over recent years from over 9.5 tons per hectare to around 7.5 tons per hectare (FAO, 2008). The low yields have been attributed to poor agronomic practices, low use of inputs especially fertilizers , low soil fertility, limited access to good quality seeds , diseases especially bacterial wilt late blight and viruses and insect pests.

Thomas, D. B., & Baimah, 2011 [24], pointed out that on sloping lands, terracing is necessary for reducing overland flow rates thereby contributing to water and nutrient conservation. When the soil nutrients improve, then the crop yields are most likely related to increase since the crops will have benefited from the nutrients. Some of the common terracing technologies used by farmers in Uganda are fanya juu andbench terraces. Bench terraces are commonly made on steep slopes and they are labor intensive. For this reason, bench terraces are rarely excavated directly but instead they are developed over time from fanya juu terraces. Fanya juu terraces are made by digging a drainage channel and throwing the soil upslope to make a ridge. Just like in the case of contours, grass and multipurpose trees can be planted on the ridges to help stabilize the ridges, prevent erosion and provide fodder and tree products (Thomas & Biamah, 2011) [24].

Farm size and land endowments also affect adoption either positively or negatively. In some empirical studies, a positive relationship between adoption of bench terrace technology and farm size is often found when food security is not a binding constraint or when there are fixed transaction and information acquisition costs associated with the new technology, therefore preventing smaller farms to engage in innovation. Households with large farms can choose to apply a given technology widely and there by reap economies of size (Langyin tuo & Mungoma, 2008). Bizoza, A.R. and Hebinck, P., (2010) found that in Ethiopia, plot size positively and significantly affected both the likelihood of adoption and intensity of technology use.

Understanding the factors that affect the adoption of bench terrace technology agricultural practices is essential for targeting and planning interventions by government, development practitioners, and nongovernment organizations (NGOs). Agricultural management practices comprise a number of key characteristics that may affect their adoption decision at the farm level in one way or another. The literature on the adoption of agricultural technologies, including on sustainable land management(SLM) practices that reduce soil and nutrient loss through degradation, is extensive (Adimassu et al., 2016) [17]. In areas where soil erosion is common, nutrient depletion occurs and this causes the land to become unproductive (Adimassu et al; 2014. Kassie et al, 2009a) [17,18]. In response, farmers tend to invest in agricultural and Bench terrace practices that have potential to improve land productivity. The adoption of agricultural practices that have potential to improve soil organic carbon, in particular, has potential for enhancing farm productivity, income, and food security.

Evidence from published research shows that the most important part of agricultural research, development, and innovation occurs only when farmers adopt and implement agricultural practices that enhances oil carbon (Koirala et al., 2015; Powlson et al., 2011) [26,27]. Improving soil organic carbon is important because it improves soil properties, which, in turn, ensures the sustainability of soil functions that are critical for ensuring that ecosystem functioning is maintained and hence crop and livestock production (Powlsonet al., 2011)[27]. However, in East Africa, the adoption of agricultural management and Bench terrace practices that enhance soil carbon by farmers is still limited (Adimassuet al., 2014) [17]. An analysis of the factors that influence the adoption of carbon-enhancing practices by farmers can help to unravel what constrains or facilitates farmers' ability to invest in these practices.

Evidence from the literature shows that various factors influence the adoption of bench terrace technology practices, such as households' socioeconomic characteristics, biophysical characteristics, plot and farm characteristics, and institutional factors (Gebremed hinet al., 1999; Requier-Desjardins et al., 2011; Liniger et al., 2011)) [28]. Variation exists, however, in the way different studies categorize these factors.

Some studies categorize these factors into (i) economic, social, and institutional (Feyisa; 2017) [29];(ii) economic, social, physical, and technical factors, and risk attitude of the farmers; (iii) farmers' characteristics, farm structure, institutional characteristics, and managerial structure; (iv) information, economic, and ecological; (v) human capital, production, policy, and natural resource characteristics; and (vi) institutional, technological, economic, financial, physical, human, cultural, and household-specific factors (Obayelu etal., 2017).

The approach taken in this paper is that technologies or engineering devices are artifacts developed by people. The field of technology and engineering has been studied by a variety of disciplines employing perspectives that have ranged from technological determinism and an (neo-classical) economic view of technology development to social-constructivism and actor network theory (Bouma, et al; 2008) [8]. We will not provide a complete overview of all these theoretical perspectives. Instead, we will formulate a synthesis of the different positions which, we believe, can be used to understand soil and water conservation as structures that are man-made, and which, consequently, contain and reflect codes and assumptions about how to construct and use these structures.

Technology development and transfer necessarily involves an interface between the world of designers and experts and that of the users. Bench terraces are not simply neutral engineering devices but are designed on the basis of assumptions made by engineers about how they should work in particular contexts (Bizoza A.R and Hebinck P, 2010). Technologies are socially shaped: bench terraces can only work (in the eyes of the designers) if they are constructed and maintained in certain ways. When designing terraces, agricultural engineers tend to situate them in hypothetical rather than real societies. Assumptions, for example, about the amount of labor available for construction and maintenance feed into the design. But bench-terraces are socio-technical rather than purely technical constructions. An example of this is when their construction is undertaken by state driven forms of farmer organization.

Terraces are seen as effective technical devices to conserve and improve soil properties and soil productivity in the highlands of erosion prone countries like Rwanda (Posthumus and and Stroosnijder, L., 2010) [30]. This has a big relationship with the crop yields because the terraces will stabilize the soils and when the fertilizers are applied then the soil fertility rejuvenates and supports crop and plant growth. Apart from terraces, other technologies to protect and improve soils include trenches and contour bounds, water harvesting techniques and planting trees.

Numerous studies show that the construction and maintenance of bench terracing entails huge labor and financial investments. This means that it is extremely difficult to erect them on an individual basis. The shortcoming of these studies and classical approaches to soil conservation, however, is their one-dimensional focus on the technical dimension of terrace construction, notably steepness and soil suitability, the lack of any account of the position of the participants (the natural resource users themselves), and the reliance on experts (Bizoza, A.R. and Hebinck, P., 2010).

While there has been a substantial analytical focus on local knowledge in interaction with expert knowledge (Keeley and Scoones, 2013) [31], few studies actually analyze the difficulties of terrace construction and maintenance in the context of the histories of state-farmer relationships and social and institutional arrangements or procedures. Literature shows the interrelation between the social and technical dimensions of bench terraces. The Rwandan state has historically as well as contemporary occupied a central role in the construction of soil and water conservation infrastructure and in the formation of farmer organizations'. The underlying dynamics involved with the construction of bench terraces and organizations and the results of conservation programs in Rwanda are thus understood in this article as the interplay between the attempts of the state to bring ready-made technologies and institutional frames and codes of conduct (that are expert designed) and the local reworking (or adaptation) of these by local people, (Blanco, H and Lal, R. 2010) [4].

The potential capability of the new technology, in terms of enhancing yield, reducing cost of production and give rise to higher profit, are also substantially important. The problem, however, is that when a technology first introduced, uncertainty with respect to its functioning under local settings is often high. Also, it is difficult to tell its economic outcome with certainty. However, over time, as farmers adopt and become familiar with the new technology, the uncertainty and the cost associated with it will fall (Nkonya, et al; 2008) [32].

Some farmers may fail to adopt the technology totally if they think that it simply doesn't function well under their circumstances, or if the size or type of their farm operation is not suited to the technology in question (Posthumus, H. and Stroosnijder, L., 2010) [30]. Concerning farmers' rationality, Posthumus, H. and Stroosnijder, L., (2010)[30] also argued that: "Farmers' objectives and rationale may be very different from those of the scientist. They have to be aware of risk and may have a multiplicity of objectives which may not include yield maximization or profit maximization. They have to make complex decisions about allocation of scarce resources, taking into account the inter-linkages between different enterprises. These decisions are made in a context of the whole household economy, including consumption and non-farm income and the multiplicity of objectives." (Sanginga, et al, 2010) [10].

Shife-raw, et al; (2009)[10] stated that the characteristics of a given technology are important determinants of adoption. In addition, the characteristics of the farmers such as age, household size, farm size, education, experience and the farming enterprises are also some but few factors that may influence the adoption decision.

Exposure to education may enhance the awareness of a new technology and hence increase the capacity of the farmers to apply a given technology. Spiteri and Nepal, (2006)[33] in the case of Uganda indicated that education had a significant effect on farmers' choice to adopt maize production technologies. Other study by Nkonya et al. (2008)[32] also shows similar effect. The size of the household has been identified to positively influence the rate of fertilizer adoption in Eastern Oromia, and the probability of adopting of improved fallow in Zambia (Amsalu and de Graaff, 2007) [48]. In theory, the positive role of access to credit in enhancing the rate of adoption of technology has been well acknowledged. Farming experience can also determine farmers' awareness of and interest to a given technology and their ability to implement it. In one study conducted in Northern Tanzania, farming experience was the most important factor positively affecting the probability of adoption of improved maize seed (Nkonya et al., 2008) [32].

The age of a farmer is also another important characteristic of a farmer that affects adoption of a technology. However, in the literature we find different relationships between age and adoption of a technology. Some findings (Pender, et al; 2004) [5] revealed negative relationship between age of a farmer and adoption whereas Tenge, et al; 2014) in the case of Bangladesh identified a positive relationship between the two. Still other findings reported there is no relationship between age and adoption of a technology. In the above discussion we tried to give some theoretical insight into some of the factors that affect adoption of a technology [55].

"The current economic theory of adoption is based on the assumption that the potential adopter makes a choice based on the maximization of expected utility subject to prices, policies, personal characteristics, and natural resource assets. A discrete choice of technology is made that leads to a level of input use and profit" (Sserunkuuma, 2005). Farmers take into account only those aspects of their operation that are relevant from a private standpoint. This process typically involves only on farm considerations (FAO, 2016) [3]. However, the benefits associated with the use of a conservation technology accrue beyond the farm. But, if the farmer who bears the costs does not realize those gains, the voluntary adoption of preferred technologies might not occur [56].

As farmers' adoption of technologies indicates the project achievement and is what one look forward to when implementing a soil conservation project, one needs to understand the targeted farmers if they are in the position to do things as required. "The ultimate goal of any soil conservation project is to have target farmers adopt (or continue use) practices recommended or implemented on their farms" (Feyisa et al; 2017)[29].

But to attain success in soil conservation implementation, Kassie, et al; (2009a) argue that it is to learn the state of mind of farmers concerning perception, attitude, acceptance and adoption. According to Larsson (2010), farmers are expected to have perceptions of the problems, and have a positive attitude towards solving them, and then they would step by step accept the methods that they think could solve the problems and adopt after they have been sufficiently used. Adoption of soil conservation measures thus come about after farmers have passed through these three states of mind, except when a short cut is applied in the form of incentives or privileges. This type of adoption is weak and unstable, as the farmers might discontinue use of a technology any time when such assistance/incentive programs come to an end. Farmers who seemed to be adopters (who have structures built on their plot) in the occurrence of incentives start to destruct conservation structures or don't make maintenance and lack of maintenance ultimately leads to destruction (non-adoption).

Establishing the Net Returns of Irish Potatoes and Beans among Farmers with and without the Bench Terraces

Considering the potato crop, at about 20% of the cropped area, occupies a prominent role in the farming systems in the surveyed districts, (Alobo, et al; 2011) [2]. Farmers combine the different system components to achieve several objectives, such as food security (through own production or cash purchases), cash availability, risk minimization, and social prestige. Unfortunately, most system components compete for the farmers' scarce resources. Whereas no attempt was made to investigate nonfarm enterprises, with about 25% of respondents in most districts being part-time farmers and about 10% reporting off-farm income sources, nonfarm enterprises are clearly important system components. Most households also own one or more kinds of livestock, mainly poultry, goats, sheep, pigs, and cattle. Livestock contribute to the system in terms of cash, protein, manure, draft power, and prestige, (Alobo, et al; 2011) [2].

Potato (*Solanum tuberosum* L.) is a crop of major economic importance worldwide (FAO, 2008). In terms of global production, it is the third most important food crop after rice and wheat for human consumption and over a billion of people on earth feed on potatoes (Adimassu, et al; 2016) [17]. Global potato production is estimated at 20.8 t ha-1, and potato yield vary considerably across regions. Generally, Asia and Europe are the world's major potato producing regions, accounting for more than 80%; while Africa is the least, accounting for about 5% (FAO, 2013). Nationally, potato yields in Uganda have remained low at 7.5t ha-1 compared to other countries in which case, 40-60 t ha-1 are achievable (FAO, 2013). The low yields are attributed to poor quality seed among other factors (Byarugaba *et al*., 2013) [34].

The potential demand for seed potatoes in Uganda is estimated at 239,328 tonnes and seed availability is only 0.13% of potential demand. The demand for potato seed has been increasing due to the great interest that farmers have in potato farming and emergency of processing factories within the region. Lack of quality seed has encouraged potato farmers to resort to planting home saved tubers from previous harvests or sourced from markets and neighbors (KAZARDI, 2014) [35]. Such tubers are often of poor health status due to latent infections by the bacterial wilt (Rastonia solanacearum), viruses and other tuber-borne pathogens (Kinyua et al., 2011) [36].

Emerging initiatives and technologies have been used to address the challenge of unavailability of certified and quality declared seed potato in the Eastern and Central Africa (ECA) region, which include seed plots techniques, positive seed selection, and production of mini-tubers (Kinyua et al., 2011) [36]. However, these require additional supportive policies for recognition and regulation of seed production and distribution in the potato value chain. The initiatives on seed potato quality improvement have not been fully effective, due to institutional limitations of the actors along the seed potato value chain.

Irish potato is the world's fourth largest food crop after wheat, rice and maize. World production reached a record 320 million tonnes in 2007 and production in the developing countries has almost doubled since 1991, with a corresponding increase in consumption (FAO, 2018). Potatoes are an important source of food, employment and income in developing countries (FAO, 2016) [3]. The potato's high energy content and ease of production have also made it an important component of urban agriculture which provides jobs and food security to some 800 million people globally (Hoffler and Ochieng, 2008) [37]. Hundreds of millions of people in the developing countries including Kenya are facing food crisis as the cost of their staple foods continues to rise. Rice prices have almost doubled during the year 2008, as wheat prices are climbing rapidly while maize prices are skyrocketing. But On the contrary, the price of potato has remained stable. The potential of the potatoes is yet to be fully realized and has never been more evident until the recent rising prices of rice, wheat and maize (FAO, 2016) [3].

Potatoes and Beans have the potential to relieve the pressure of increasing cereal prices on the poorest people and contribute significantly to food security. Potatoes are grown and eaten locally, with little significant international trade compared to cereals, so they are particularly valuable as food in the developing countries. Potatoes mature in 3-4 months and can yield about 40 tons/ha and hence ideally suited to places where land is limited and labour is abundant (FAO, 2008).

Kenya is the fifth biggest potato producer in Sub-Saharan Africa, with an output of 790,000 tonnes in 2006, (Keeley and Scoones, 2013) [31]. In Kenya, the crop is second most important staple food crop after maize and plays a major role in national food and nutritional security. Furthermore, the crop is an important food and cash crop in the medium and high rainfall areas. In high and medium rainfall areas, it is grown by about 500,000 farmers, cultivating 108,000 ha with an annual production of over 1 million tonnes in two growing seasons. It is also grown together with beans in the drier parts of the country during the short rains season when maize will normally do poorly. Potatoes are often eaten with beans in most poor rural households during the 'hunger period' just before the maize crop matures in the long rains sea son. They are also included in the basic diet of maize and beans as a vegetable to add flavor and variety (Kebebe et al; 2017) [38].

In Kenya, potatoes are mainly cultivated in the high altitude areas (1500-3000 m above sea level) where Kenya's main staple food has no comparative advantage. These areas include slopes around Mt. Kenya, such as Meru, Embu, and Kirinyaga; parts of Laikipia and on both sides of the Nyandarua (Aberdare) range that coves parts of Nyeri, Muranga, Kiambu and Nyandarua Districts. They are also grown in the highlands on Mau Escarpment (Mau Narok and Molo), Tinderet, Nandi Escarpment and Cherangani hills. Small acreages are also cultivated in Kericho and Kisii areas and isolated patches near the Coast in the Taita hills (Kirumba et al., 2004) [39].

Highland farmers can complete three planting seasons with potatoes (each season being 3-4 long) unlike maize, which takes up to 10 months in these areas to mature. Potato thus becomes a steadier source of income and is planted both as a cash crop and staple food by farmers. Above 2100 m above sea level, potatoes grow faster than maize and the total energy and protein production per hectare per day is higher for potatoes. Over 70% of potato production is in this zone. At these altitudes the net revenue per hectare for potatoes is more than double than of maize (Sayer, et al; 2013). Thus for land restricted Ethiopian, potatoes are a logical and important crop to promote in the highlands areas.

While average potato yields in North America and Western Europe often reach 40 tonnes per hectare, yields in developing countries are usually below 20 tonnes per hectare. The national average potato yields for Uganda has been reported at 7.7 tons per hectare, but this figure has fluctuated considerably over recent years, from over 9.5 ton/ha to around 7.5 ton/ha (FAO, 2016). The low yields have been attributed to poor agronomic practices, low use of inputs especially fertilizers, low soil fertility, limited access to good quality seeds, diseases (especially bacterial wilt, late blight and viruses) and insect pests (MOA, 2005). Fertilizers and pesticides are being used at rates below economic optimum since farmers direct their resources to other high value 'important' crops such as pyrethrum, onions, tomatoes, barley, tea, coffee, maize, beans and wheat (Nganga et al., 2002).

According to 2005 FAO statistics, Ugandan potato production of 585,000t from 86,000 ha and Kenyan production of 980,000t from 120,000 ha, indicate national average yields of about 7- 8t/ ha for the two countries. This is low compared to the 25t/ ha that can be attained by progressive farmers under rainfed conditions (Zimmermann, et al; 2009) [16]. This yield gap can be attributed to high incidences of diseases, particularly late blight and bacterial wilt, the use of low quality seed potatoes degenerated by viruses, inadequate soil fertility management and poor general crop husbandry.

In Uganda potatoes and beans are essentially a food security crop with steadily growing urban domestic markets. Projections for future growth are somewhat obscured by lack of sound empirical data on production and demand. According to FAO, 2016 statistics, the production of potatoes in Uganda (2000) was approximately 450,000 metric tons, produced on approximately 65,000 ha with an average yield of 7 metric tons / ha. However, a recent study by the national potato programme, estimated production up to 1.2 million metric tons per annum, with on farm yields of 14.5 metric tons, whereas the most recent Household survey produced a production total of 290,000 metric tons, with a yield of 4 metric tons / ha.

The production of beans in Uganda is constrained by a lack of inputs including clean seed, fertilizers and pesticides. There are limited commercial producers and the farmers are as well constrained by poor storage facilities. There is a general lack of organization in the marketing chain, particularly amongst producers. Combined with seasonal production, this leads to considerable price instability. Due to lack of transparency and poor market structure, brokers are able to charge excessive fees for their services and travelling traders make the bulk of the profit in the supply chain, (KAZARDI, Biodiversity project, 2014) [35].

The Perceptions of the Farmers on the Uptake of Bench Terraces Technology

Despite scientific advances in understanding the causes and outcomes of land degradation, uptake of Bench terrace practices is mostly limited to a minority of innovative land-users and practitioners. Although principles and practices of Sustainable Land Management are well-known and increasingly promoted at the policy and development cooperation level, land degradation is still increasing and becoming a major global threat. This demonstrates the wide gap existing between acknowledgement of the need for Sustainable Land Management and the implementation of successful Bench terrace practices (Teshome et al., 2016) [40].

Uptake of bench terrace technologies is affected by various factors, usually categorized into; farm specific characteristics, technology specific attributes, and farmer's socioeconomic characteristics. Examples of such variables that have been found to influence technology adoption include: farm size, farmer's age, education, social networks (e.g. membership of association), dependency ratio, gender, access to agricultural advice and information, land tenure security, soil fertility, soil type, income, input availability, access to markets, risk aversion behaviour, technology awareness, farming experience, adequacy of farm tools, technical and economic feasibility of using the technology, agro-ecological conditions, access to credit and presence of enabling policies (Boyd & Turton, 2008;). Some of these factors increase adoption; others reduce adoption; while others have mixed effects, as illustrated in the examples below. Input and output uncertainties (regarding the costs of technology use and added benefits) are forms of risk that farmers face when deciding whether or not to adopt new technologies.

Identified reasons for poor implementation of bench terrace technology for Sustainable Land Management (SLM) are related to technological, ecological, institutional, economic and socio-cultural aspects. Lack of access to appropriate technologies, practices or equipment is a major barrier in many countries. This may either due to a lack of access to knowledge and information on Sustainable Land Management options and their proper implementation, or because of insufficient resources in land, labor, inputs, biomass, energy, water or plants, (Ssewanyana and Kasirye, 2010).

Bench terrace practices that are technically effective or suitable for one specific site location are not necessarily the best option for other site locations with different biophysical constraints and socio-economic contexts. It is therefore important to have area- and case-specific technological packages accompanied by the necessary capacity-building measures and resources for appropriate implementation. Often, knowledge gaps of the ecological implications at different spatial and time scales make it difficult to select the most suitable SLM options, (Tadesse and Belay, 2004).

Adoption of bench terrace technologies in agriculture has attracted the attention of development economists and sociologists because the vast majority of the population in developing countries derives its livelihood from agricultural production and because there are opportunities for increased output and higher income levels which technological change can offer (Borras, S. and Franco, C., 2010) [25]. Adoption studies relate to use or non-use of a particular technology by individual farmers at a point in time, or during an extended period of time. Adoption therefore presumes that the technology exists, and studies of the adoption process analyze the determinants of whether and when adoption takes place (Bouma, et al; 2008) [8].

The decision to uptake a new or improved technology/practice can be regarded as an investment decision (Keeley, J., and Scoones, I., 2013) [31]. This decision may involve sizeable fixed costs, while the benefits realized over time. The choice of whether or not to adopt a new technology will, therefore, be based on a careful assessment of a large number of technical, economic and social factors. The technical feature of a new technology may have a direct consequence on the decision making process. It appears that the more technically complicated the innovation, the less attractive it may be too many farmers (Latour, B., 2005).

Environmental constraints for implementation of certain Bench terrace practices. As local environmental characteristics (climate, topography, soil quality) often determine the success or failure of Bench terrace practices, initial characterization of baseline conditions will help to select the most suitable land use and/or management option, depending on local conditions and considering both on-site and off-site benefits, (Thuo et al; 2014) [41]. Institutional and governance issues are often major barriers that hinder the adoption of Bench terrace practices. For example, governance structures that aggravates or inhibits decision-making at different scales neither encourage cross-sartorial planning, nor address land tenure issues, but cause instability over time. There is an urgent need for well-trained and effective extension services to facilitate and guide implementation, monitoring and evaluation of the impact of local Bench terrace practices, (Sommer; et al; 2016) [42].

Limited finance and access to capital for implementation and maintenance of Sustainable Land Management. Economic considerations and incentives schemes are two of the land users 'primary motivations for selecting SLM technologies and practices, including a strong dependence on external subsidies for implementation and maintenance, (Thuo et al; 2014) [41].

Household size; In most of the studies reviewed, household size exerts positive influence on the adoption of bench terrace technology among farmers (Kassie et al., 2015; Ndiritu et al., 2014) [43]. This could be because most of these practices, for example, the construction and maintenance of soil and water conservation measures such as soil/stone bunds, are labor intensive. Laboris crucial in the adoption of Bench terrace practices, especially during installation and for maintenance. Consequently, households with more members (i.e., economically active household members) can invest easily in bench terrace technologies (Kassieet al., 2015; Ndiritu et al., 2014) [43]. This is because family labor can be channeled to labor-intensive soil and land improvement practices. Small-sized households are more likely to adopt less labor intensive practices such as the use of fertilizer compared with manure or compost.

Nevertheless, labor availability has varied effects on the adoption of bench terrace technologies. For example, the use of manure increases significantly with the availability of family labor but declines with an increase in casual labor (Wainaina et al; 2016) [44]. The implication of this is that, although manure application is a labor-intensive process, when collection and application are done using casual laborers, a cost element is introduced and this acts as an additional constraint (Kamau et al., 2014) [20].

The adoption of almost all the carbon-enhancing practices requires a cash outlay for the acquisition of inputs and labor. The positive effect of off-farm income on the adoption of soil bunds, mixed farming, and tree planting indicates that it facilitates the adoption of practices that require some cash outlay for implementation. Cash from off-farm income may facilitate the initial implementation of an agricultural or sustainable land practice through the purchase of seed and seedlings in the case of crops and agro-forestry, respectively. In the case of soil/stone bunds, however, cash income is used largely for implementation and maintenance. Low income among farmers is, therefore, a major limiting factor in the adoption of agricultural technologies that enhance soil carbon. In Western Kenya, the adoption of soil fertility management, soil erosion control, and the use of inorganic fertilizer is more common among wealthy farmers than among poor farmers (Kamau et al., 2014) [20]. The importance of income cannot, therefore, be overemphasized in that it improves farmers' livelihoods by relaxing the capital constraint and it stimulates farm productivity by facilitating the adoption of improved technologies especially in areas with a poorly developed credit market (Ketema and Bauer, 2012) [45].

Nevertheless, involvement in off-farm income generating activities has a negative impact on the adoption of technologies because it diverts labor from on-farm activities. Farmers who are involved in off-farm activities are likely to encounter time and labor constraints for investing in intensive Bench terrace practices such as soil/stone bunds and the use of manure (Wainaina 2016) [44].These findings suggest that farm households need to prioritize their needs before pursuing income-related objectives. The implication is that, when introducing new technologies, there is a need for development partners' to focus on opportunity cost aspects.

Farmers' experience; the duration for which a household has been growing trees (i.e., experience) positively influences the density and diversity of tree species, and hence the sequestration of soil carbon. The same applies to fertilizer use, whereby farmers who have used it over a long period are likely to continue using it. This could be because of technical information and economies of scale that farmers acquire over time (Pender and Gebremedhin, 2006) [46].

Arable land (farm) size; Farm size has a mixed effect on the adoption of different bench terrace technologies in both Kenya and Ethiopia. For example, large plot size has a positive effect on the adoption of intercropping, soil and water conservation, minimum tillage, and the use of fertilizer and manure (Mugwe et al., 2014; Ogada et al., 2014) [47]. The positive effect of farm size on the different bench terrace technology (i.e., soil bunds, soil/stone bunds, compost, farmyard manure, and gulley treatment) suggests that these practices may not be strictly scale neutral or that the opportunity costs facing farms vary systematically by farm size. The positive effect of farm size could also be because farm size is highly correlated with household wealth, which may help in easing the financial constraint since land could be used as collateral.

The negative effect of land size on the adoption of various bench terrace technologies is because, when land availability is not a problem, farmers may not worry about soil erosion and degradation, thereby reducing their propensity to invest in bench terrace technology (Adimassu et al., 2016; Pender and Gebremedhin, 2006) [17]. Diminishing farm size may hinder the adoption of practices that have potential to sequester carbon (Teshome et al., 2016) [40]. For example, Thuo et al. (2014) [41] show that small farm size negatively affects the adoption of improved varieties of groundnuts, while households with large farms are likely to adopt the use of manure and tree. These findings suggest that household's with larger landholdings have an advantage associated with economies of scale, thereby investing in technologies that improve soil fertility and hence agricultural productivity and income (Kebebe et al., 2017) [38].

Land tenure; by drawing a parallel from the reviewed studies in Ethiopia and Kenya, it is apparent that the effects of different socioeconomic factors vary under different types of land tenure. For example, Ogada et al. .(2014) and Wainaina et al. (2016) [44] note that households with tenure security have a higher probability of adopting the use of inorganic fertilizer, stone terracing, and manure. However, this is not always the case as tenure security has also been shown to have a negative and significant influence on the use of inorganic fertilizer and zero tillage. This could be because of differences in decision making processes as influenced by the type of landownership (i.e., whether the land is rented or owned). Bench terrace technologies that demand high reliance on machinery and agro-chemicals for maintenance result in spiraling expenditure and, given the difficulty in obtaining sufficient income for employing laborers, they are prohibitive. However, farmers who own land could use their title deeds as collateral to obtain credit.

The observed differences in the effect of socioeconomic factors on the adoption of bench terrace technologies could be associated with the type of tenure systems (i.e., farm or some plots being owned while others are in-rented). Households with secure land tenure are more likely to adopt long-term soil conservation measures such as stone terraces and agro forestry (Nyaga et al., 2015), and vice versa. For example, in cases in which farmers own land, and possess the title deeds, their land-use rights are well established on the land and they can, therefore, invest in long-term improvement.

Slope of plots; the results show that farmers invest more in physical practices that enhance soil carbon in plots with steep slopes, because of the more obvious erosion risks and rates of loss of soil fertility than in plots on gentle slopes. For instance, the adoption of stone bunds, terraces, soil bunds, and minimum tillage is more likely on steep slopes for preventing soil erosion and fertility loss (Wainaina et al., 2016) [44]. Ndiritu et al. (2014) also found that soil and water conservation and fertilizer are less likely to be used on flat plots. However, soil conservation measures and the use of bench mark terrace are likely to be applied on slopes (FAO, 2016).

Land tenure and security of tenure are considered to be key institutional dimensions. Indeed, land rights became a critical factor in the mid-1950s when farmers began to migrate in search of land (Wainaina et al; 2016) [44]. The wars of the 1990s led to the forced displacement of farmers, and their gradual return has added to an environmental question of great political sensitivity: all Rwandese people have the right to access land but this result in increased pressure on the land.

Land tenure and rights are part of a heated debate because of their strong links with land use. Policy documents state that for soil erosion control and water conservation to be successful, land relations need to be privatized. The assumed linear relationship between land investment and security of tenure is ambiguous, however. This is partly because of the coexistence and overlap of different legal systems in Uganda. Until recently, the state has claimed ownership of the land with only usufruct rights for users (Musahara and Huggins 2005) [1].The current law, adopted in 2005, moves away from usufruct rights and aims to register and commoditize land. Private land rights are considered an appropriate vehicle for a land market and land investments, and thus for constructing and maintaining terraces.

However, customary land rights are still predominant in Ethiopia. Inheritance rather than the land market shapes the transfer of land from generation to generation and from one person to another, effectively creating an informal land market. Farmers believe strongly that the land belongs to them despite the progressive nature of formal titling. Most farmers keep an ibuku (book) that contains measurements of their land. Farmers largely rely on their own land and have little opportunity for renting land elsewhere (Mbabazi, et al; 2013) [22]. In situations where land markets are absent, informal contracts appear to be the best strategy for accessing land. However, this may lead to situations where farmers are reluctant to invest in land or build terraces on rented fields. Informal land access arrangements are also likely to affect farmers applying for loans and credit.

Current land laws in Uganda and Rwanda do not necessarily create security of tenure but of ownership instead. In their study of Ghana, Kenya and Rwanda, Musahara and Huggins (2005) [1] found that land rights were not a significant factor in determining investments in land improvement. Grisley and Mwesigwa, (2015) [23] argue that 'the stability of tenure, rather than ownership, is the more important factor shaping a farmer's decision to invest in soil productivity and adopt sustainable land-use practices'. Security of tenure allows farmers to maintain and invest more in their land and to obtain long-term land-use rights. The current legal situation in Uganda is therefore not conducive to the soil erosion control declared as an important governmental goal (Musahara and Huggins 2005) [1].

Strategies for Increasing the Uptake of Bench Terraces Technology

For successful up scaling and to foster large-scale implementation of Sustainable Land Management, more attention must be paid to the social system from the first involvement stage, up to long-term maintenance. Ensuring stakeholder participation throughout decision-making processes, from the design of Sustainable Land Management projects all the way to implementation and monitoring, will increase the likelihood of acceptance and implementation of Sustainable Land Management. From start to end, the process should be highly solution oriented, emphasize Sustainable Land Management, and combat a local-participatory approach with global knowledge sharing, (Grisley and Mwesigwa, 2015) [23].

More comprehensive multi-objective assessments, including: co-benefits, trade-offs, barriers for implementation and enabling conditions of single or combined Sustainable Land Management technologies, and practices, are still lacking. Using existing experiences to learn, we must promote future research on how to foster synergies focusing on comparative and more integrated studies. This will be essential for scaling up SLM technologies, while still tailoring them to specific ecological and socio-economic realities, (Spiteri and Nepal, 2006) [33].

A framework that assesses cost-benefits and trade-offs also promotes the uptake of more coherent Sustainable Land Management choices at different scales (in time and space)of implementation. Such frameworks will facilitate moving towards developing strategies and processes that involve stakeholders at all levels, link bottom-up experience with science-based data and knowledge, and make the best Sustainable Land Management choices to simultaneously address climate change adaptation and mitigation and land degradation. Simultaneously addressing these multiple objectives and goals could be facilitated by a pragmatic and integrated framework to track the best technical choices and to promote the necessary enabling environments and co-benefits, as well as by addressing trade-offs at the appropriated scales and taking specific circumstances into account, (Posthumus, H. and Stroosnijder, L., 2010)[30].

Scientific evidence shows that Bench terrace practices like bench terraces, if widely adopted, as a means to prevent, reduce or revert land degradation and in achieving the LDN (SDG 15.3), also contribute to adapting to, and mitigating, climate change. Furthermore, they help to maintain biodiversity, and they contribute to other SDGs in a number of ways, by alleviating poverty, and foster economic prosperity for land-dependent communities. However, one size does not fit all; specific circumstances need tobe carefully taken into account, and there are no silver-bullet SLM solutions. Each environmental and socio-cultural context requires assessment of the most appropriated ways to achieve multiple benefits and to reduce trade-offs through SLM, (Borras and Franco, 2010) [25].

Policy; Investment in rural areas and sustainable land management is a local concern, a national interest and a global obligation, (Borras, S. and Franco, C., 2010)[25]. Thus it must be given priority (1) at the local level to increase income, to improve food security and to contribute to poverty reduction; and (2) at the national and global level, to help alleviate hunger and malnutrition, to reduce poverty, to protect the world's climate, to safeguard natural resources and ecosystem services, and in many cases to preserve cultural heritage. Sustainable agricultural practices need to be stimulated by further emphasizing improved production and reduced costs. Production benefits are the primary interest of land users, and have direct consequences for livelihoods in small-scale subsistence farming. A major portion of the land used for agriculture, particularly in ecologically fragile areas, is cultivated by smallholder farmers who perform significant ecological services in the process. But for economic reasons, and also owing to lack of knowledge, their use of available resources in many cases is characterized by inappropriate technologies and methods. These smallholder farmers must be given much more effective support, (Blanco, H and Lal, R. 2010) [4].

Enabling Environment: An enabling environment should be nurtured for sustainable land management to thrive best. Indirect measures such as infrastructure, access to credit and inputs, favorable prices for agricultural products, and legislation indirectly contribute to sustainable use of natural resources. Security of land use rights is a major component affecting conservation: policies that improve the rights of individual land users are a prerequisite for sustainable land management. Compensation for ecosystem services: Farmers are key agents in maintaining the world's terrestrial ecosystems. Rural areas may need and deserve compensation for the environmental services they provide from more affluent, economically advanced regions. This could consist, for instance, of innovative systems to compensate upstream land users in watersheds, of global mechanisms to finance carbon sequestration in soils, or of in-situ preservation of agro-biodiversity, (Mbabazi, 2013) [22].

Knowledge Management: There is a need for investment in documenting and evaluating bench terrace practices and in assessing their impact on ecosystem services. Scattered knowledge about SLM needs to be identified, documented and assessed in a thorough and interactive review process that involves the joint effort of land users, technical specialists, and researchers, (Mbabazi, 2013) [22]. Documented knowledge about Bench terrace practices must be made broadly available for land users, decision-makers, etc. to provide basket of options for decision-making at different levels. Many Bench terrace practices have been documented. Their sustainable effect and practical implementation have also been confirmed in many cases at the local level. But there is a great need to clarify their impact indifferent contexts and to adapt and optimize them under different conditions, (Tenge, 2014). Additional new technologies need to be developed. Among other things, the role of soils in climate change mitigation and adaption is an issue of urgent concern.

Awareness Raising and Capacity Development:

Many resource users, extensionists, researchers, policy-makers and decision-makers are insufficiently informed with respect to the causes, the context, and the impacts of inappropriate resource use. Major efforts in information and training will be necessary if Bench terrace practices are to achieve a break-through.Topics unilaterally related to short-term increases in yield and productivity are frequently a current priority for extension services. On the other hand, extension advice concerned with sustainable resource use and with preservation and strengthening of ecosystem services is neglected. In future, extension services must provide more information on Bench terrace practices, (NEMA, 2011) [13].

Participation and Community Involvement:

Bench terrace practices can be implemented most efficiently if all actors involved (farmers, extensionists, researchers, and decision-makers) participates in decision-making processes (selection, development, adaptation, planning, and implementation). Successful implementation of SLM often requires close cooperation between neighbors or members of a village community. Providing information, imparting knowledge, and exchanging experience play a key role in each of these steps, (Alobo, et al; 2011) [2].

Planning for Sustainable Land Management:

Land management is not a purely local issue. It is often beyond the means, responsibility and decision-making power of single land users. Off-site impacts due to inappropriate land management can be severe and should be considered in planning and decision-making at the local level. Therefore, overall regional planning (e.g. in an entire watershed), taking account of on-site and off-site interactions, needs to be given sufficient attention. Mapping of degradation and conservation coverage is essential, in order to visualize the extent and effectiveness of achievements that support sustainable land management. It is also a prerequisite for proper planning of investments in SLM, (Tenge, and AJM. 2005) [49].

Multi-Functional Use: Multi-functional use helps considerably to reduce risk through diversification, to promote synergies that produce added economic, ecological or social value, and to preserve and strengthen important ecosystem services. SLM concerns all of us and pays off in many more ways than recognized, (Tenge, 2005) [49].

Increasing Soil Organic Carbon (SOC) stocks is key to most bench terrace practices, and provides synergies for addressing degradation of land decimals and disaster risk reduction, climate change adaptation and mitigation. Besides contributing to climate change mitigation by removing Carbon dioxide from the atmosphere, enhancing organic carbon in soils improves soil health and fertility, water and nutrient retention capacity, food production potential and resilience to drought. The potential and magnitude of each of these benefits will depend on the baseline conditions, and local environmental, socio-economic and cultural conditions, (Spiteri, A. and Nepal, K.S., 2006) [33].

Bench terrace practices have a strong potential to enhance Soil Organic Carbon sequestration, although estimates of this potential should consider the full Greenhouse Gas (GHG) balance, including possible interactions between the carbon and nitrogen cycles that could affect the net climate change mitigation potential of applied practices. Even when the mitigation potential of Sustainable Land Management is not fully achieved, its impact on Soil Organic Carbon should be considered, since increasing Soil Organic Carbon has crucial positive benefits for achieving, climate change adaptation, food security, and protecting biodiversity, (Keeley and Scoones, 2013) [31].

Large-scale adoption of bench terrace practices in all managed ecosystems (irrigated and rain fed croplands, grazing lands, forests and woodlands) could theoretically sequester about 1–2Gt Carbon per year globally within 30–50 years, although estimates vary in magnitude depending on which land-use categories, management practices, and Green House Gases fluxes are included. At any site, the rate of Soil organic carbon (SOC) sequestration through Bench terrace practices declines over time and declines as the saturation level is approached. The main carbon sequestration potential is in degraded soils. In soils with high SOC content, preventing SOC losses is priority. Overall SLM provides an opportunity to recover between 21 to 51 Gt of the lost carbon in the world's agricultural and degraded soils. The achievable local or regional SOC sequestration may be higher or lower than the theoretical SOC sequestration potential based on local environmental, socio-economic, cultural and institutional contexts, (Kirsten, 2009) [50].

Databases such as the World Overview of Conservation Approaches and Technologies (WOCAT), TERRAFRICA, the World Bank sourcebook, and the Voluntary Guidelines for Sustainable Soil Management (VGSSM) provide comprehensive recommendations and examples of Bench terrace practices. The combined implementation of practices that address both soil and water conservation, the diversification of cropping systems, the integration of crop and livestock systems, and agro-forestry are most effective and should be prioritized, (Keeley, J., and Scoones, I., 2013) [31].

According to "A global initiative for sustainable land management," around10-20% of dry lands and 24% of the world's productive lands are degraded. Many of the people affected by land degradation live in developing countries where the need to increase agricultural production is greatest. Land degradation, desertification and climate change alone, or interactively, can affect the regulation, support, provisioning and cultural services of terrestrial ecosystems (McKeon, et al; 2014) [51]. Mismanagement of land already threatens, and will continue to threaten, future global food and energy security, enhance water insecurity, and hamper capacities to adapt to, and mitigate, climate change and also alter biodiversity. Bench terrace practices, combined with rehabilitation activities, can be an opportunity to create green jobs and enhance rural economic activity, as recently demonstrated in a sustainable business case in Ghana (The New Economy, 2014) [52]. Engaging private sector investments, networking and partnership-building is required, as well. Not only top-down, but also more bottom-up approaches are necessary. For example, Community-Based Adaptation (CBA) and Nature-Based Solutions (NBS) at a local level could be options for preserving and recovering ecosystem services, and therefore also for addressing land degradation and climate change causes and impacts at this scale.

Sustainable Land Management is commonly considered as the main approach to prevent, mitigate and reverse land degradation, but it can also serve as an integral climate change adaptation strategy, being based on the statement that the more healthy and resilient the system is, the less vulnerable and more adaptive it will be to external changes and forces, including climate. In that regard,

SLM can be considered a land-based approach, which includes the concepts of Ecosystem-Based Adaptation (EBA) and Community-Based Approach (CBA), (The New Economy, 2014).

Irrigation is also a form of intensification in that water is an input used to increase the value of the land's output. It is not always sustainable, leading to soil salinity and depletion of water reserves; some estimates suggest that salt-affected soils cover about 10 percent of the world's land area, and one-third of the arid and semi-arid regions (Alobo, et al; 2011) [2], while FAO believes that one developing country in five will face water shortages by 2030. But irrigation that is sustainable could be regarded as SLM, building up organic matter; and it could have considerable on-farm benefits. Indeed Shiferaw, 2009) [10];, reviewing potential for carbon sequestration in dry lands, has advocated irrigation, including the use of sewage sludge and wastewater, as an important tactic for accumulating biomass and therefore SOC:

There is real potential for expanding sustainable irrigation. Rurangwa, (2012) [8] reports that in 1999, 42 percent of arable land was irrigated in Asia and 31 percent in the Near East and North Africa, but only four percent in Sub-Saharan Africa. Posthumus, H. and Stroosnijder, L., (2010) [30] argue that: "Although agriculture is by far the biggest water user in Africa, the full physical irrigation potential is far from being tapped. Only about one-third of the potentially irrigated area is under irrigation. Unleashing this potential could have huge benefits, especially if allied to more rational use of water. In West Asia and the Near East, rain fed wheat yield is about 1 t/ha, but can rise to 5-6 t/ha under irrigation (Posthumus, H. and Stroosnijder, L., 2010) [30]. This effect could be multiplied through greater water-use efficiency. In the Middle East, using supplemental, instead of full, irrigation on wheat to deliver 50 percent of the water requirement reduced the grain yield cited above by about 10-20 percent (Place, et al; 2007) [53]. So if the 50 percent of the water that had been saved were used to irrigate another area of the same size, the farmer would see an effective yield increase of 160 percent while using the same amount of water.

Summary of Literature

This literature has provided evidence that both political authorities and farmers were cognizant of land management during the pre-colonial and early colonial periods in Uganda. Nevertheless, the colonial and post-colonial states began to import exogenous ideas about soil erosion, notably about the value of bench terraces. The ensuing measures took the form of regulations to prevent the overuse of land, leaving little room for local farmers to participate in and own the process of soil erosion control. The implementation process was generally enforced as a top-down process rather than being participatory, which would have allowed farmer perspectives to be included. Population increase and land tenure were identified by experts and the state as key social factors shaping soil erosion control processes, (Ostrom, 2014) [54].

Past and current policies have shown a remarkable continuity of ideas. The persistence of continuities indicates the extent to which the transformation of institutional infrastructure in Africa has proceeded hardly unchanged in its content. Historical analysis allowed us to underline the continuity of prescriptions and modes of ordering in the past and present. Distinctions between the pre-, colonial and post-colonial belie the existence of important continuities. Past and present policies set out to commoditize Uganda's highland and mountain resources (e.g. land, labor, crops and cattle) and to integrate peoples' livelihoods more firmly into global economic circuits, (McKeon, et al; 2014) [51].

Bench terracing and land tenure reform have become the predominant socio-technical vehicle to achieve these aims. While the state discourse increasingly seeks to privatize land as a key to solving erosion problems, farmers, supported by some academic researchers, contest that this is an appropriate institutional solution and continue to prefer their own land tenure arrangement. Moreover, the state's discourse has given more attention to soil erosion control per se than to slowing down population growth vis-à-vis the available land. The latter seems to be a more promising trajectory for most mountainous regions in the world but requires changes at the level of the soil conservation discourse. If farmers, in collaboration with experts, find ways to improve the land (effectively increasing farm size), population pressure may be less problematic. If combined with a diversification of the rural economy, Rwanda may escape a doom scenario of poverty and insurmountable environmental problems, (McKeon, et al; 2014) [51].

Research Methodology

Introduction

This chapter dealt with the method that was used to obtain, analyse and process the findings of the study. It was arranged in terms of the research design, study population, sample size and sample selection sampling procedure, methods of data collection, research procedure. Lastly it also explained why a particular research methodology was used; the challenges that were faced during the research process and how they would be handled in order to facilitate the research process.

Study Area

The study was conducted in Kabale District specifically Rubaya sub County, which is located in South western Uganda and borders Rwanda. The area of study has a hilly landscape and borders other Sub counties, Butanda in the North West, Kamuganguzi in the North East, and the country of Rwanda in the South West.

Research Design

Research design as a plan of what data to gather, from who, how and when to collect and analyze it, as noted by (Paulin, 2007). A descriptive research design was used for this study because it helps to generalise the findings to other similar situations (Amin, 2005). The descriptive research design aimed at obtaining information to systematically describe the population and the phenomenon where the research was conducted in Rubaya Sub County. Both quantitative and qualitative approaches were used in order to establish the extent and rate of the problem. Hence, under these approaches, semi-structured questionnaires and interview guides were used to obtain information from the specific respondents in the study area.

Quantitative research approach

Quantitative research approach was used to collect numerical data because the numerical data was needed to make inferences on the number of farmers with and without terraces and the crop yields of potatoes and beans from farms with and without terraces as well as the incomes of the farmers with and without bench terraces. This data was collected by use of questionnaire and the data was presented numerically using tables and pie charts. The questionnaires were administered generally to the selected farmers with either bench terraces or without. This approach as recommended by York (1998), who explained that quantitative research is about prediction, generalising a sample to a larger group of subjects and using numbers to prove or disprove a hypothesis.

Qualitative research approach

Qualitative research approach was applied because it helped to obtain information that was explanatory narrative and this was helpful in making inferences on ideas shared by the respondents both farmers and technical personnel. The information was gathered using interview guides where the interviews were conducted on selected farmers and farmer groups as given out by the Agricultural extension officer of Rubaya Sub County. This method of research was used because there was a need to interact with the farmers with and without bench terraces for in-depth information. The Agricultural officer and other technical staff provided more information on perception of bench terracing and on strategies of uptake of bench terraces. The use of interviews was thus a guide to collect the qualitative information for research.

Study population

The target population for the study was derived from the households (farmers) as land users and owners in Rubaya Sub County. The study was conducted in Rubaya Sub County with a population of 4018 people. However, research was conducted within 5 parishes that have a total population of 2991 people and considering a population of 1,349 farmers who are actively engaged in farming.(Sub county annual report, 2019). The technical team including the Agricultural officer, Community Development officer, Sub county chief and the secretary for production at the sub county level were approached to get in depth understanding about the perceptions of up taking the bench terraces technology. The study population constituted farmers in Rubaya Sub County, who were either having bench terraces or not. The study chose the respondents from a target population of 100 farmers who had bench terraces and 100 farmers who did not have bench terraces from where the sample was derived. This constituted a target population of 200 study units.

Sample size and sample selection

The sample size was based on the formula by Slovene which is the formula used to determine the ideal sample size for the population. The formula states that n=N/1+ (N*e^2) where n= number of samples, N= Total population, e = Margin of error (which will be 5% or 0.05). Therefore considering the total population of 100 farmers (land users) who are both females and males the sample for farmers with bench terraces was derived from the population. Using Slovene formulae a sample of 80 respondents was reached at out of 100 targeted farmers in the population. Considering the population of 200 farmers (land users) who are both females and males the sample for farmers without bench terraces was derived from the population. Using Slovene formulae a sample of 160 respondents was obtained out of 200 targeted farmers in the population.

$$Sample\ size = \frac{N}{1 + Ne^2}$$

Where N is the Target Population (200), n is the sample size and e is the level of significance at 0.05

$$Sample\ size = \frac{200}{1 + 200(0.05)^2} \approx 134$$

Therefore, the sample size for the study was 134 respondents.

Sampling procedure

The study employed both purposive sampling technique which was used to select the farmers with bench terraces and simple random sampling which was used to select farmers without bench terraces. The technique involved getting an interval considering the nth value, for purposes of getting a uniform representation of the respondents.

Purposive sampling

Purposive sampling was a deliberate non-random method of sampling, which aimed to sample a group of people or settings, with a particular characteristic, usually in qualitative research designs. Purposive sampling was used to select farmer groups who were identified by the Agricultural extension worker as key informants to give information relating to the study under investigation. Purposive sampling assisted the researcher to remain focused on the key respondents with adequate knowledge that was valid for the study.

Simple random sampling

Simple random sampling as a sampling technique was applied where every item in the population had an even chance and likelihood of being selected in the sample. The main attribute of this sampling method was that every sample had the same probability of being selected. The technique involved marking each member in the population with the nth value and numbering them from 1 up to N.

Simple random sampling was used to select the farmers with and without bench terraces since every farmer in the study area was given the same chance to be selected as an informant to give information relating to the study under investigation.

Sources of data

Two sources of data were used for purposes of this research. These were primary data and secondary data.

Secondary data

Roston (2001) defined secondary data as that kind of data that is available, already reported by some other scholars. Secondary data included policy documents and abstracts of the various scholars relating to the topic of discussion in question. Secondary data for this study was got from sources like libraries, archived records from the sub-county, records of land users who use bench terrace technology, government publications on bench terrace technology and land management, online information, text books, newspapers, and unpublished research reports. This was because it would be readily available and easier to comprehend, as it comprises of extensively researched work.

Primary data

According to Roston (2001), primary data is that kind of data that has been gathered for the first time, it has never been reported anywhere. Short comings of secondary data sources such as out datedness and inadequacy in terms of coverage necessitated the use of primary source for first data. Self-administered questionnaire will be used and this will enable the researcher to cover a large population quickly and at a reasonable cost.

Methods and Instruments of Data Collection

Questionnaires

The questionnaires was used to obtain data for the research because the observation was that in considering the various research options for systematically gathering information, the questionnaire had earned the right to be a perennial favourite, a frequent choice of researchers because of its versatility, its time and cost efficiency and for its overall ability to get the job done (Ruane 2005:143). Therefore the questionnaires were used to obtain the information from farmers with and without bench terraces. The questionnaire was used and it was specifically administered to the respective respondents in the study.

Interview

The interview refers to a personal exchange of information between the interviewer and the interviewee (Bowling, 2002:147). The interview guide was used to interview Agriculture Officers and the sub-county administrators to get in depth understanding of factors influencing the adoption of the bench terraces technology. The researcher also used the interview guide to derive information from farmers groups by conducting interviews face to face with farmers. The use of interviews helped to avoid misinterpretation of the questions as the researcher was assisted to interpret questions that were not properly understood by the respondents such that immediate responses were obtained.

Documentary Analysis

Researched information was used as literature review which enabled to find opinions and responses of other researchers about the problem under investigation and make comparison. This was a better source for secondary data.

Observation

Observation is the active acquisition of information from the primary source. In living beings, observation employs senses while in science, observation can involve the recording of data via the use of scientific instruments, (Bowling, 2002). Observation method was applied by looking at how bench terrace technology was applied in order to achieve sustainable land management. This method was preferred by the researcher because it brought out information that was expressed verbally or in actions observed.

Data Quality Control

Validity

The validity of the instruments involved testing them for validity of values using expert judgment method as recommended by Amin (2005). Concerning the validity, the researcher was guided by the supervisor and contacting Sub-County authorities to rate the instruments to help the researcher have a valid instrument. The validity of the questionnaires was based on the peoples' advice and then the validity index would be measured using CVI formula and the rate is expected to be 0.7.

$$CVI = \frac{No\ of\ items\ regarded\ relevant\ by\ judges}{Not\ of\ items} =$$

Where: CVI= Content Validity of Instruments

n= Number of items indicated relevant

N=Total number of items in the questionnaire

Reliability

This is the measure of the degree of which a research instrument yields consistent results after repeated trials. The reliability of the instrument is increased by reviews of instruments by more experienced people and field tests on appropriate population. The researcher used questionnaires to different people in an area that have similar characteristics and setting as the area of the study (Rubaya Sub-County). This was intended to minimize errors and increase reliability of the data collected through taking corrective action based on the pre-test results.

Research procedure

An introductory letter for the research was obtained from the University Authorities. Further authority was got from the Sub county leadership and the community where the research was carried out. This helped to gain entry to the area of study and have a mandate by authority concerned in the administration and management circles.

Data management and analysis

Data collected was checked for consistence, interpreted, coded and analysed using Statistical Package for Social Scientists Version 20 and Microsoft excel. The data analysed was got from the farmers with and without bench terraces. The farmers provided information on the amount of land with and without bench terraces where Irish potatoes and Beans have been planted for consideration of the previous two seasons. The farmers were required to provide information for the output obtained from the Irish potatoes and Beans planted in the previous two seasons. The yields from the land holdings with and without bench terraces were obtained by dividing the total output over the area covered by the Irish potatoes and Bean crop in the respective seasons as pointed out by the farmers.

In the data analysis, the study used descriptive statistics to compare crop yields and net returns on crop yields, correlation to determine the relationship, and test the probability value approach to test the hypothesis. Qualitative data was used to determine the factors hindering the uptake of bench terraces technology and the strategies for increasing the uptake of bench terraces technology.

Ethical Consideration

The respondents were briefed about the aims, significance and use of the study findings. The respondents were assured of confidentiality on their responses, and care was exercised to protect their rights. Human dignity was respected and also the names of the respondents were not to be disclosed.

Data Analysis And Interpretation

Introduction

The chapter presented a detailed analysis and interpretation of the findings. The analysis was based on objectives of the study.

Response rate

The study was cross sectional in nature. It applied the descriptive statistics and it had a sample target of 134 study units of which only 100 responded. This was a response rate of 75%.

$$Response\ rate = \frac{Number\ of\ complete\ questionnaires\ returned}{Number\ of\ questionnaires\ distributed} \times 100$$

$$Response\ rate = \frac{100}{134} \times 100 = 75\%$$

This response rate was considered to be adequate for conclusion and generalization.

Background Data

The study investigated different background characteristics, the findings of which were summarized in the table below.

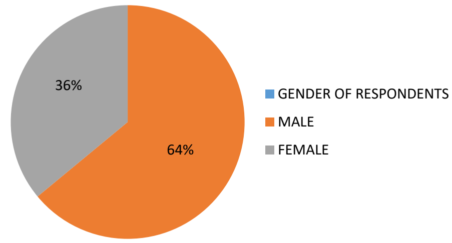
Table 1: Background data

Variable list	Categories	Frequency	Percent	Valid Percent
Gender	Male	64	64	64
	Female	36	36	36
	Total	100	100	100
Marital status	Married	72	72	72
	Single	8	8	8
	Widowed	20	20	20
	Total	100	100	100
Education	Primary	56	56	56
	Secondary	24	24	24
	Tertiary	20	20	20
	Total	100	100	100
Do you have bench terraces on your land	Yes	44	44	44
	No	56	56	56
	Total	100	100	100
Age groups	Below 35	16	16	16
	35 – 49	36	36	36
	50 and above	48	48	48
	Total	100	100	100

Source: Field data 2021

The data was further aggregated into the charts as indicated;

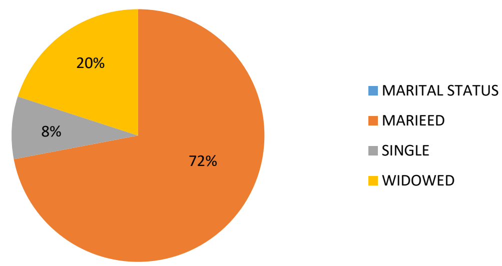
Figure. 2: Gender of the respondents.



Source:Field data 2021

The study showed that 64% of the farmers were male while 36% were female. The difference in the participation was possibly because in the study area male counter parts own land and have full control of the resource.

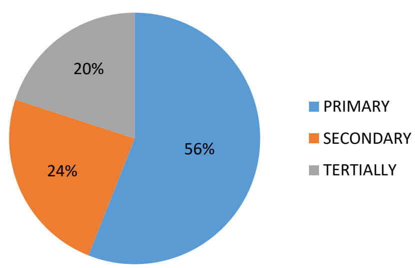
Figure 3: Marital status of the respondents.



Source: Field data 2021

According to marital status, the study showed that 72% of the farmers who participated were married, 8% were single while 20% were widowed. The fact that majority of the farmers were married suggests that the married are independent and have a big control of the land resource.

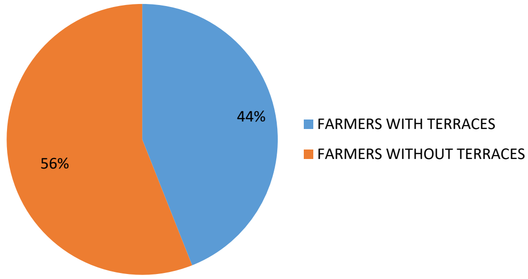
Figure 4: Education level of the respondents.



Source:Field data 2021

The findings on the level of education of the farmers who took part in the study indicated that 56% had attained primary education, 24% had attained secondary education, while 20% had attained tertiary education. This implied that most of the farmers who took part in this study had primary education level possibly because several of the highly educated consider farming to be for the people of the lower class.

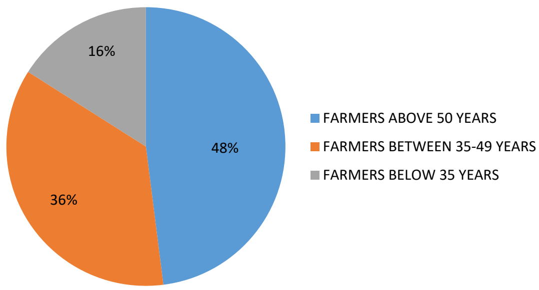
Figure 5: Farmers with and without bench terraces.



Source:Field data 2021

When asked whether the farmers had bench terraces, the study showed that 56% did not have bench terraces while 44% had them. This suggests that most of the farmers who took part in this study were not using bench terraces technology possibly because the technology has not been supported by the government in extension systems and promotion of sustainable land management technologies is not given first priority.

Figure 6: The age of the respondents.



Source: Field data 2021

In comparison to the age differences, it was found that 48% of the farmers were old (over 50 years), 36% were adults (35 – 49 years) while only 16% were youths (below 35 years).

The research found out that almost all the participants (98%) acknowledged having heard about promotions of bench terraces in their community,

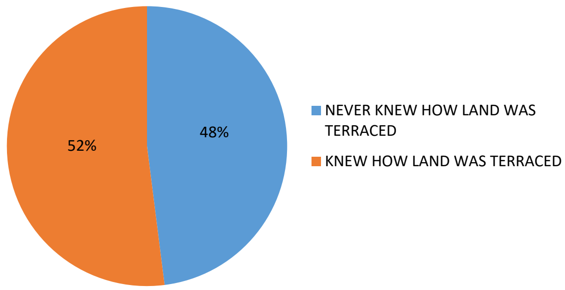
Table 2: Source of funds for terracing

	Frequency	Percent	Valid Percent	Cumulative Percent	
Valid	External support	4	4.0	7.7	7.7
	Personal money	48	48.0	92.3	100.0
	Total	52	52.0	100.0	
Missing	9	48	48.0		
Total		100	100.0		

Source: Field data, 2021

The data was aggregated using the Pie-charts.

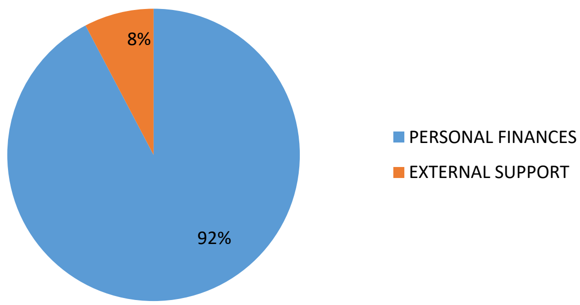
Figure 7: Knowledge about how land was terraced.



Source: Field data 2021

When participants were asked how they terraced their land, 48% could not indicate how their land was terraced. This could have been due to fact that the owners by the time of the research could have inherited the land when it was terraced or could have bought it when it was already terraced.

Figure 8: Source of funding for terracing.



Source:Field data 2021

Of the 52% who could ably indicate how they terraced their land, 7.7% had terraced their land through external support while 92.3% had terraced their land using personal money. The statistics generally imply that majority of the farmers are using personal finances to terrace their land, which limits the technology to only those with financial ability.

Analysis of the Research Problem

The researcher analysed the research problem basing on the research objectives. Consequently, the techniques of data analysis depended on the research objectives.

Objective one

To estimate the crop yields of the common food crops; Irish potatoes and beans among farmers with and without bench terraces in Rubaya Sub county Kabale district.

The objective called for a comparison in harvests in both crops (beans and Irish), and the application of bench terraces (those with and those without bench terraces). Since crop yields were measured in kilograms, the researcher used mean (descriptive statistics) to determine the mean annual crop yield for all the farmers. Secondly, since the study involved a comparison in crop yield among farmers with and without bench terraces, the researcher used a comparison of the mean (SPSS statistical procedure) to compare the crop yields among farmers. The table below summarizes the outcome on crop yield among farmers.

Table 3: Total Quantity(s) harvested (Kgs) in the season of 2019/2020

Do you have bench terraces on your land	Type of crop grown	Count	Percent	Mean crop yield (kg)
Yes	Beans	28	29.2	444
	Irish	12	12.5	4720
	Total	40	41.7	1727
No	Beans	36	37.5	495
	Irish	20	20.8	506
	Total	56	58.3	499
Total	Beans	64	66.7	473
	Irish	32	33.3	2086
	Total	96	100	1011

Source: Field data, 2021

The analysis on differences on crop yields was based on 96 farmers. This suggested that of the 100 farmers who took part in the study, the information provided by 4 of the farmers constituted invalid cases and were eliminated from this analysis.

Of the 96 farmers whose crop yields were analyzed and compared, 40 farmers (41.7%) were using bench terraces technology on their land while 56 farmers (58.3%) were not using bench terraces on their land. This was possibly because the construction of bench terraces is quite expensive and few farmers afford the expenses incurred in the process of terracing.

In terms of the crops grown, 64 farmers (66.7%) grew bean in 2020 while 32 farmers (33.3%) grew Irish potatoes. Therefore, most of the farmers in 2020 grew more beans than Irish potatoes possibly because much of the Irish potatoes was grown in the lower valleys commonly referred to as wetlands/ Swamps.

A distribution of the types of crops grown among the farmers using bench terraces in 2020 shows that 28 farmers (29.2%) grew beans while 12 farmers (12.5%) grew Irish potatoes. The statistics suggest that beans were commonly grown on bench terraces than Irish potatoes.

Similarly, a distribution on the types of crops grown among farmers who were not using bench terraces shows that 36 farmers (37.5%) grew beans while 20 farmers (20.8%) grew Irish potatoes. These statistics suggest that beans were commonly grown on non-benched terraced land than Irish potatoes.

The researcher observed that regardless of the application of bench terraces, most of the farmers grew beans on their farms. The dominance of beans among the farmers in Rubaya Sub County generally suggests that beans being one of the common legume crops, it is easier to secure in terms of seed, plant and manage for the common peasant farmer.

Understanding how the crop yields are calculated

The crop yields are calculated by using the formula, where the farmer needs to determine the average number of plants per acre, the average number of pods (for the beans) per plant and average number of seeds per pod as well as the average number of tubers (for the Irish potatoes) per plant. The formula would thus be

A=Average number of plants per acre

B=Average number of pods (for the climbing beans) and

K=Average number of seeds per pod

(A*B)/K (for the Climbing beans).

However, practically the farmer's yields could not be determined using the formula but rather would depend on measuring the total harvests for the different crops immediately after harvesting and as well determine the number of sacks of Irish potatoes harvested for each season. This helped the researcher in computing the different yields from the crops grown and these were the findings. A distribution on the annual crop yield in 2020 indicates some differences in harvests. The study shows 495 kg as the mean annual beans yield among farmers who had bench terraces and 444 kg among farmers who did not have bench terraces. There was thus a slight margin and difference in yields of 51 kgs. Therefore, beans yields were better among farmers who had bench terraces than those who did not have bench terraces.

The study also shows 4720 kg as the mean annual yield of Irish potatoes among farmers who used bench terraces and 506 kg among farmers who did not use bench terraces. Therefore, Irish potato yields were better among farmers with bench terraces than those who did not use bench terraces. This was possibly because the farm inputs like manures and fertilizers applied in the bench terraces would fully be used by the crops and thus planted Irish potato benefited from the nutrients since they would not be eroded by any run off or there would be no soil erosion from terraced fields.

The researcher concludes that crop yields on bench terraced farms were better than crop yields on farms without benched terraces technology. The practical implication on this, thus indicated that bench terraces should be promoted by development practitioners as a means of having degraded land rejuvenated into productive and arable land for agriculture.

Table 4: Total Quantity(s) harvested (Kg) in the season of 2020/2021

Do you have bench terraces on your land	Type of crop grown	Count	Percent	Mean crop yield (kg)
Yes	Beans	24	30	2208
	Irish	16	20	2549
	Total	44	55	5949
No	Beans	12	15	138
	Irish	24	30	918
	Total	36	45	658
Total	Beans	36	45	1518
	Irish	40	50	1571
	Total	80	100	3568

Source: Field data, 2021

The analysis on differences in crop yields in the season of 2020/2021 was based on 80 farmers. This suggests that of the 100 farmers who took part in the study, the information provided by 20 of the farmers constituted invalid cases and were eliminated from this analysis.

Of the 80 farmers whose crop yields were analyzed and compared, 44 farmers (55%) were using bench terraces technology on their land while 36 farmers (45%) were not using bench terraces on their land.

In terms of the crops grown, 36 farmers (45%) grew bean in 2021 while 40 farmers (50%) grew Irish potatoes. Therefore, most of the farmers in 2020 grew more Irish potatoes than beans.

A distribution of the types of crops grown among the farmers using bench terraces in 2021 shows that 24 farmers (30%) grew beans while 16 farmers (20%) grew Irish potatoes. The statistics suggest that beans were commonly grown on bench terraces than Irish potatoes. Similarly, a distribution on the types of crops grown among farmers who were not using bench terraces shows that 12 farmers (15%) grew beans while 24 farmers (30%) grew Irish potatoes. These statistics suggest that Irish potatoes were commonly grown on non-benched terraced land than beans. This was possibly because in the 2020/2021 season, much concentration was put on growing beans than Irish potatoes and thus farmers opted to plant the beans mainly on terraces.

The researcher did not observe significant differences in the crops grown on both farms with bench terraces and farms without terraces. The absence of a significant difference in the crops grown on both terraced and un-terraced farms among the farmers in Rubaya Sub county generally suggests that there should be other elements like use of Fallow methods, application of Manure and a combined force in using all the sustainable land management package for improved Agriculture production and productivity.

Computing the crop yields of the crops grown

The researcher was helped by the estimates given by the different farmers and in the computations; a distribution on the annual crop yield in the season of 2020/2021 indicates some differences in harvests. The study shows 2,208 kg as the mean annual yield of beans among farmers who used bench terraces and 138 kg among farmers who did not use bench terraces. Therefore, beans yields were better among farmers who used bench terraces than those who did not use the bench terraces. This is possibly because all the Agronomic practices on terraced land like the manure applied remains in the garden and is fully utilized by the crop compared to the non terraced land where the manure applied would be washed away by the surface run offs whenever it rains.

The study also shows 2,549 kg as the mean annual yield of Irish potatoes among farmers who used bench terraces and 918 kg among farmers who did not use bench terraces. Therefore, Irish potato yields were better among farmers with bench terraces than those who did not use bench terraces. This was possibly because the water runoffs on the non terraced land would wash away the applied manure and all the fertile soils are easily washed away leaving the soil bare and infertile.

A critical observation of crop yields in the season of 2020/2021 shows that farms with bench terraces had better crop yields than the farms without bench terraces. The implication to this study indicated that the Agriculture extension system should embrace the sustainable land management practices and technologies as a measure to address the challenging land management component.

Table 5: The total mean of the quantity(s) harvested in Kgs according to the seasons.

Farmers	Season 2019/2020		Season 2020/2021	
With bench terraces	Crops		Crops	
	Beans	Irish potatoes	Beans	Irish potatoes
	444kgs	4720kgs	2208kgs	2549kgs
Without bench terraces	506 kgs	138 kgs	918 kgs	495 kgs

Source: field data 2021

From the table, the minimum mean yield of the Beans for the farmers with bench terraces was 444 kgs and the maximum mean yield was 2208 kgs, while the minimum mean yield of the Beans for the farmers without bench terraces was 138 kgs and the maximum mean yield was 495 kgs respectively.

Thus, the minimum mean yield of the Beans was 138 kgs registered among farmers without bench terraces in season 2020/2021 and the maximum mean yield was 2208 kgs registered among farmers with bench terraces in the season of 2020/2021 respectively.

Among the farmers who grew Irish potatoes, the minimum mean yield of the crop from the farmers with bench terraces was 2549 kgs and the maximum was 4720 kgs. While still the minimum mean yield of the Irish potatoes among farmers without bench terraces was 506 kgs and the maximum was 918 kgs respectively.

Therefore, the minimum mean yield of Irish potatoes was 506 kgs registered among farmers without bench terraces in season 20219/2020, and the maximum mean yield was 4720 kgs registered among farmers with bench terraces in season 2019/2020 respectively.

Objective two: To compare the net returns of the common food crops; Irish Potatoes and Beans among the farmers with and without bench terraces in Rubaya Sub county Kabale district

This objective called for a comparison of the net returns in both crops (beans and Irish), and application of bench terraces (farms with and without terraces). The researcher computed the difference between the costs of production and the average sales from the crop yields. The researcher used the compare mean (SPSS statistical procedure) to compare the net returns on the crop yields.

Total sales were determined from the questionnaire, and measured in shillings. The cost of production was an aggregate of the cost of making terraces, cost of land preparation, the cost of planting, the cost of weeding, the cost of spraying, the cost of harvesting, and other related costs of production. The different costs were computed as variables in SPSS. The net return, which is the difference between total sales and costs of production, was also computed as a variable in SPSS. The tables below show the outcome on net returns in the respective seasons.

Table 6: Net returns (Ug shillings) in the season of 2019/2020

Do you have bench terraces on your land	**Type of crop grown**	**Count**	**Percent**	**Mean returns**
Yes	Beans	28	29.0	1,121,365
	Irish	12	12.6	1,995,144
	Total	40	41.6	2,116,303
No	Beans	36	36.7	474877
	Irish	20	22.6	799,321
	Total	56	59.3	561207
Total	Beans	64	65.7	965056
	Irish	32	35.2	2,661577
	Total	96	100	1,973,722

Source: Field data, 2021

The analysis on the net returns on the crop yields in the season of 2019/2020 was based on 96 farmers. This suggests that of the target 100 farmers who part in the study, the information provided by 04 of the farmers constituted the invalid cases and were eliminated from this analysis.

This analysis was also based on the 40 farmers (41.6%), who used the bench terraces and 56 farmers (59.3%) who were not using the bench terraces in the season of 2019/2020. The analysis also considered the total number of 64 farmers (65.7%) who grew beans and a total number of 32 farmers (35.2%) who grew Irish potatoes in the season of 2019/2020.

For the farmers who used bench terraces, 28 farmers (29%) grew beans and 12 farmers (12.6%) grew Irish potatoes. The annual net returns for farmers with bench terraces on their crop yields were UGX. 1,121,365 from the Beans and UGX.1,995,144 from Irish potatoes respectively. The statistics suggests that farmers with bench terraces fetched more from Irish potatoes than from beans. This was possibly because the prices of Irish potatoes were always higher during the harvesting seasons.

Among farmers who were not using bench terraces, 36 farmers (36.7%) grew beans and 20 farmers (22.6%) grew Irish potatoes. The annual net return on their crops was UGX. 474,877 from beans and UGX.799,321 from Irish potatoes respectively. There was still a sight higher return from the sale of Beans and Irish potatoes because prices of Irish potatoes were always higher during the harvests seasons compared to the prices of beans.

It was thus observed that the net returns of the farmers using the bench terraces was higher than the net returns of the farmers without bench terraces for both crops respectively. This was attributed to the fact that the bench terraces hold better the soil nutrients and water for crop growth and development.

Table 7: Net returns (Ug shillings)in the season of 2020/2021

Do you have bench terraces on your land	Type of crop grown	Count	Percent	Mean returns
Yes	Beans	24	35.3	952,599
	Irish	16	23.5	2,660,203
	Total	40	58.8	1,635,640
No	Beans	20	29.4	316,585
	Irish	8	11.8	893,600
	Total	28	41.2	481,447
Total	Beans	44	64.7	663,502
	Irish	24	35.3	2,071,335
	Total	68	100	1,160,384

Source: Field data, 2021

The analysis on the net returns on crop yields in the season of 2020/2021 was based on 68 farmers only. This suggests that of the 100 farmers who took part in the study, the information provided by 32 of the farmers constituted invalid cases and were eliminated from this analysis.

This analysis was also based on 40 farmers (58.8%) who used bench terraces and 28 farmers (41.2%) who were not using bench terraces on their farms in the season of 2020/2021. The analysis was also based on 44 farmers (64.7%) who grew beans and 24 farmers (35.5%) who grew Irish potatoes in the season of 2020/2021.

Among the farmers who used bench terraces, 24 farmers (35.3%) grew beans and 16 farmers (23.5%) grew Irish potatoes. The annual net returns on the crop yields were UGX. 952,599 from the Beans and UGX.2, 660,203 from Irish potatoes respectively. The statistics suggests that farmers with bench terraces fetched more from Irish potatoes than from beans. This was possibly because sales of Irish potatoes are in comparison to what is harvested, and the bump harvest from Potato would mean selling large quantities of Irish potatoes.

Among farmers who were not using bench terraces, 20 farmers (29.4%) grew beans and 8 farmers (11.8%) grew Irish potatoes. Their annual net return on their crops was UGX. 316,585 from beans and UGX.893,600 Irish potatoes respectively. The difference in net returns on beans and Irish potatoes among farmers who were not using bench terraces was relatively small.

Table 7: Net returns (Ug shillings)in the season of 2020/2021

Farmers	Season 2019/2020		Season 2020/2021	
With bench terraces	Crops		Crops	
	Beans	Irish potatoes	Beans	Irish potatoes
	1,121,365 shillings	1,995,144 shillings	952,599 shillings	2,660,203 shillingss
Without bench terraces	474,877 shillings	799,321 shillings	316,585 shillings	893,600 shillings

Source: field data 2021.

From the table, the minimum mean net returns from the Beans for the farmers with bench terraces was 952,599 UGX and the maximum mean net returns was 1,121,365 UGX, while the minimum mean net returns from beans for farmers without bench terraces was 316,585 UGX and the maximum mean net returns was 474, 487 UGX respectively.

Thus, the minimum mean net returns from the Beans was 316,585 UGX registered among farmers without bench terraces in season 2020/2021 and the maximum mean net returns was 1,121,365 UGX registered among farmers with bench terraces in the season of 2019/2020 respectively.

Accordingly the farmers who grew Irish potatoes, the minimum mean net returns from the sales among farmers with bench terraces was 1,995,144 UGX and the maximum was 2,660,203 UGX. The minimum mean net returns among the Irish potatoes farmers without bench terraces was 799,321 UGX and the maximum mean net returns was 893,600 UGX respectively.

Thus, the minimum mean net returns from Irish potatoes was 799,321 UGX registered among farmers without bench terraces in season 20219/2020, and the maximum mean net returns was 2,660,203 UGX registered among farmers with bench terraces in season 2020/2021 respectively

Based on the statistics above, the researcher concludes that farmers with bench terraces fetched more on their crop yields than those who were not using bench terraces. This was possibly because all the crop farm inputs applied on the bench terraces are fully utilised by the crops and are not eroded away by run-offs.

The researcher also observed that regardless of whether the farms were bench terraced or not, the net returns from Irish potatoes were significantly higher than the annual net returns from beans. On the whole, this research therefore, found out that farmers' net returns from bench terraces outstrip farmers' net returns from farms that are not bench terraced.

Objective three

To identify the perception of the farmers on the uptake of bench terraces in Rubaya Sub County Kabale district.

To understand and identify the perceptions of the farmers on the uptake of bench terraces, the researcher designed two open-ended questions that were administered to farmers. The first question sought for farmers' opinions on the perceptions about the uptake of bench terraces. Three factors strongly emerged out of their response that is lack of money, awareness, and attitude

Lack of money

The aspect of money was reported by majority of the respondents. There were some farmers who looked at bench terraces from the business perspective. These farmers regarded the limitation to the uptake as 'lack of capital'. They looked at the initial construction of the bench terraces to be an investment that required huge start-up capital. In their response, it was noted that such capital requirements were lacking to most of the farmers. For example, one farmer commented on the idea of capital as follows: " Iam engaged in farming on a small scale not because I want it that way, but because of limited capital to invest in farming as a business,"

The researcher found that the few farmers who indicated lack of capital as a limitation to the uptake of bench terraces were those who harvested big from their terraces. Additionally, most of the farmers that considered the aspect of capital were already using bench terraces on their farms. They seemed to have loved the technology but perhaps were limited by the initial capital requirements for expansion. This was observed from one farmer who said: "making one terrace alone cost you UGX 50,000, which is had to raise and for many of us find it had to consolidate this amount of money at once and this scares away even those who feel it would be fine to invest in terracing"

The researcher further found that some of the farmers who indicated the monetary aspect as a limiting factor to uptake of bench terraces had small land acreages. They considered lack of money as a limitation to extend their farms to undertake benches. These farmers seemed to appreciate and admire those who were using the technology, and particularly those who had large pieces of land. One farmer who expressed money as a limitation to extending his land to uptake benches said: "…the technology itself is so good but it favours farmers with large pieces of land. My land is indeed small, and at the same time scattered in different places which if consolidated would only make one (1) acre! It is only that I do not have money to terrace my land…" This means that many farmers would have taken up the technology, but when they look at the monetary aspect, they are thrown out. It also appears that some of the farmers could not take up the bench terracing because their land was fragmented already. These farmers would look at lack of money as a limitation to taking up the bench terraces technology. For example, one farmer made a comment on the size of the land: " *My pieces of land are too small and fragmented and since these pieces of land are too small I have the fear that in case I terrace my land it can even become more smaller yet the expenses incurred in terracing it are not easily realised."*

The other terms, which farmers used to express the monetary aspect involved in the uptake of bench terraces include *'labour intensive'*, 'poverty', and 'expensive to construct'. In the researcher's opinion, participants love the bench terraces technology but are handicapped due to the money required to take up this type of technology.

Awareness

Bench terraces technology seems to be new in this region and in Rubaya Sub county it started in 2015. Consequently, few farmers might be aware of this form of technology, leave alone using it on their own farms. The idea of awareness was derived from such statements like "…lack of awareness…", "…farmers are not sensitized…" these statements suggest how limited farmers were aware regarding the uptake of bench terraces. One young farmer pointed out "the land belongs to my father who is an old man and he gave it to me and tagged on *it some rules, I cannot therefore offer it up for bench terraces without the consent of the old man"*. This suggests that neither the old man nor the young farmer were aware of the potential benefits of terracing their land but are not willing to take it up.

The researcher found that farmers were not aware that bench terraces technology is to benefit smallholder farmers, particularly those with small pieces of land. They could not uptake bench terraces because they thought it requires large pieces of land. Farmers reported that their land was small and could not be taken up for bench terraces. The average acreage of land among the farmers investigated was about 0.45 acres. Most of the farmers, including those whose land is up for bench terracing have small land pieces of land. Therefore, there is some degree of unawareness that the said technology is to help small land acreage owners to obtain the most out of their small land. On this account, one of the farmers said: "*…my pieces of land are very fragmented. I fear that they might be made smaller if I gave them for bench terraces…*" perhaps the idea here was hinged on the fact that land was fragmentation.

The researcher found that farmers were not aware that the land would be terraced and remain in the hands of the farmers. Actually some of the farmers knew that after the terraces have been introduced on their land, the land would be taken from them. One of the farmers reiterated that: "*…bench terracing is good but very expensive for an ordinary farmer. People fear that their land may be taken if terraced by use of the external support either from the government or Non government organisations…*" This view is just a macrocosm of the many divergent view held amongst farmers on the uptake of bench terraces.

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The researcher found that farmers were not aware that bench terraces are a recommended technology for hilly and steep areas. Some of the farmers were worried that their land was too steep or hilly to be used for bench terraces. The use of such phrases like '*…one part of my land is too hilly and rocky…*", "*…part of my land is fragmented and on a very steep hilly slope…", and "… the landscape is too steep too accommodate the terraces…*" These statements represent a greater majority on their perceptions on the steepness of the land. This indicates that farmers in Rubaya Sub county were unaware that bench terraces technology works even when the land is too steep and hilly. In the researcher's opinion, these farmers were unaware that the problems of small pieces of land and fragmentation were the backbone of bench terraces technology.

Attitude

The researcher found a diversity of attitude held by farmers on bench terraces technology. The researcher termed the attitude as 'poor'. In consideration of all the farmers (100%) who took part in the study, they had ever heard of bench terraces technology in their community. However, only 44% were using the technology on their land. This percentage supports the poor attitude the researcher found among farmers.

In the first place, farmers indicated that bench terraces technology was very expensive. They were making conclusions perhaps without any assessment of what it required indeed. Despite seeing negative signs "*…increasing soil erosion, loss of soil fertility, reducing crop yields, soil exhaustion, washing away of manure, landslides…*" on the un terraced pieces of land; the attitude they held on bench terraces could not make them to easily uptake the bench terraces technology. Instead of adopting the technology to minimize soil erosion, land exhaustion, and low crop yield, they are still rigidly influenced by their attitude.

Secondly, some farmers considered the technology to require strong and bodied men, which would exclude the application of the technology by women and the small bodied men. The researcher found this to be attitudinal because, not all who took up the bench technology had constructed them by their own energy. The researcher found that few of the farmers had obtained assistance from Kigezi Diocese water program. However, some of the farmers who were using bench terraces had used their own money to construct the terraces. For example, one farmer who used his personal money to construct terraces on his land spent close to UGX 1,600, 000 to terraces his land. However, from the benefits of terracing such as high productivity, soil retention, and use of quality manure, the farmer does not regret. He proudly says: "…*I used my own money to terrace my land but I want assure you my land is now safer and I have already gained much from the land which was terraced and recovered what I invested in*…" The researcher found that uptake of the bench terraces technology was attitudinal because even those who were not helped by Kigezi Diocese water program could terrace their land using the small saving of their own money.

Different members in the family (husband & wife) had conflicting opinions on whether to adopt bench terraces on their land. This is supported by one farmer who said: "…*my wife is not yet convinced about putting our land for bench terraces…*" When the researcher asked why the wife was not yet convinced, the husband reluctantly said, "…*but we do not see our friends in the neighbourhood taking up this approach…*"

Objective four

To explore the strategies for increasing the uptake of bench terraces in Rubaya Sub county Kabale district

To understand the strategies for increasing the uptake of bench terraces, the researcher used two open-ended questions. The questions sought for farmers' opinions on the strategies that could be taken to increase the uptake of this technology. While most of the farmers identified a number of strategies: sensitizing farmers, government policies, constant monitoring of terraces, support from NGOs, farmers' exposure, government funding of terraces, give incentives to farmers, change farmer attitude, extension services, the study identified one factor, which was themed as 'government support'

Government financial support

The researcher found that most of the farmers who were using bench terraces had either used their own money or obtained support from Kigezi Diocese water program. None of the farmers who were using bench terraces ever obtained funding from government. Since Kigezi Diocese water project might not be in position to help all farmers in the uptake of bench terraces in Rubaya Sub County, government needs to take up this project for the benefit of her people. The government should thus promote income based projects that are geared towards sustainable land management technologies where bench terracing is inclusive.

Farmers recommended that government should come up with policies that govern the use and extension of bench terraces in rural and hilly areas. These policies would not only provide governance mechanisms but also provide a means of making the project compulsory in areas devastated hilly arrears. In view of the above, one farmer said: "…government should make it mandatory for the farmers in Kabale to terrace their land…" This farmer had used his own money to terrace the land that was about 2.5 acres. At the time of the investigation, the farmer was boosting of controlled run-off of water, improved productivity, increased soil fertility, and increased crop yield.

Government policy support

The study found that government could improve the uptake of bench terraces through her policies in the agricultural domain. For example, promotion of the Environmental acts of 1995 which spearheads the environmental conservation for sustainable land management. Farmers used the concept 'policy' about 11 times as a viable option to improving the uptake of bench terraces technology. For instance one farmer said: "…enforce the terracing of landscapes in Kabale…government should take an upper hand in land use management…" While these strategies are very significant, the study found that they require serious policing to guide their implementation. In responding to the question: Do you think there are strategies to for increasing the uptake of bench terraces? One farmer blatantly said: "…*government is not fully or even concerned about our land*… " The study found that farmers are not aware of any policy that seem to be guiding the implementation of bench terraces nor a policy that promotes land use management. While there are policies that are aligned to promoting land use management, farmers do not seem to see these policies working on ground.

One of the government policy support identified by farmers related to land use management. The study found that farmers were using the concept "sustainable land management". In its practical application, sustainable land management refers to the use of land resources including soils, water, animals and plants, for the production of goods to meet human changing needs while simultaneously ensuring the long term production potential of these resources and maintaining of their environmental functions".

Farmers looked to sustainable land management as a viable option to promoting the uptake of bench terraces technology. For example, one farmer observed: "…*it is time for government to plan for sustainable land management*… " sustainable land management is the anti dote towards the uptake of bench terraces in a way that would engage all the land users to embrace the related technologies where bench terracing is key. According to one farmer, "…*government policies should be aligned to promote bench terraces technology, which is a form of land management*…" these excerpts suggest that government policies are versatile in improving the uptake of bench terraces in Kabale.

Government partnership

The study also found the need for government to collaborate with other NGOs in the region to scale up the uptake of bench terraces technology. It was observed that Kigezi Diocese Water Programme was doing this already. Actually, the study found that some of the farmers who had enrolled for bench terraces technology had obtained support from Kigezi Diocese Water Programme. This therefore, implies that government needs to liaise with other NGOs in promoting sustainable land use management. For example, one farmer observed: "…*government should work with NGOs like Kigezi diocese to embrace terracing of land*…" This particular farmer obtained external financial support from the diocese in the initial construction of terraces on his land. The farmer was proud of the benefits of bench terraces such as "…*increased land productivity, reduced soil erosion, planted grass for animals, use less seeds to plant, and learnt good farming practices*…" This farmer reported a gross sale of approximately UGX 3,800,000 in the 2020/2021 season. the implication here is that government can collaborate with other development partners to promote the uptake of bench terraces in Kabale district.

Government Extension services

The study found that farmers were using the concept "sensitize" frequently, looking at as a possible remedy to the challenge of low uptake of bench technology. They assumed that farmers' failure to take up bench terraces was due to lack of awareness that such technology exists. Consequently most of them looked to the presence of extension workers in spearheading agricultural and land use practices. Regardless of farmer's use of the concept, it might be a viable option to increase the uptake of bench terraces in the sub county. For example, one farmer commented: "… the need for extension services to create awareness about the terraces technology should be empasised…" In another excerpt, a farmer observed: "…extension service delivery should include terracing of landscapes…" and thus extension workers should ensure that messages related to bench terracing are embraced.

Aggregating these views the study found that much as the bench terraces technology was under promotion, most farmers were not aware, neither were they sensitized on it. Sensitizing farmers on bench terraces would go along with sustainable land management. This view agrees with one farmer who said: "…the government should put extension workers meant for sustainable land management (terracing) in place…" This implies that successful implementation of bench terraces technology would require a team of extension workers to fully sensitize farmers on sustainable land management inclusive of uptake of bench terraces.

The role of extension workers in improving the uptake of bench terraces was observed in this matter, where one farmer pointed out "…we need extension systems to improve on land matters…" This particular farmer looked at the gap between high uptake and low uptake of bench terraces technology as being caused by a system under agricultural extension which was seen to be having gaps.

One of the strategies identified in improving the uptake of bench terraces was changing farmers' attitude towards this technology. In line with attitudinal change, one farmer said: "…it is time that our people change their attitude towards bench terraces technology since the most preferred and arable land has changed into non productive land that would support agricultural productivity…" The study found that farmers need to change their attitude on many farming practices. For example, most of the farmers were crying of the fragmented land on which they grew Irish potatoes and beans. A farmer would have about six small plots scattered across the village, parish or sub county. Certainly, turning out such scattered plots for bench terraces would be virtually imaginable. However, one farmer said: "…people should have to cope with upgraded and bench terrace technology…" These excerpts suggest that government, through extension workers can rally up farmers' attitude for adoption of bench terraces technology.

Testing the Hypotheses

This study tested hypotheses using the p-values approach. The p-value approach compares the test statistic with the type 1 error to be as small as 0.01, 0.05 or 0.10. In this study, the type 1 error was set to be as low as 0.05. In this approach, the null hypothesis is assumed to be true. If the p-value is less than the test statistic ($\alpha = .01$), reject the null hypothesis else accept the alternative hypothesis. Similarly, if the p-value is greater than the test statistic ($\alpha = .01$), accept the null hypothesis and reject the alternative hypothesis.

Hypotheses on the yield of the crops for the study was

H0: There is no significant difference in crop yields between farmers using bench terraces and those without bench terraces.

H1: There is a significant difference in crop yields between farmers using bench terraces and those without bench terraces.

H0: There is no significant difference in net returns between farmers using the bench terraces and those without bench terraces.

H1: There is a significant difference in net returns between farmers using the bench terraces and those without bench terraces.

From the test results, the P.value was .000 (p.value =000), therefore the null hypotheses were rejected and the alternative hypotheses were accepted.

This meant that the research findings accepted the alternative hypotheses which stated that there is a significant difference in crop yields between farmers using bench terraces and those without bench terraces and there is a significant difference in net returns between farmers using bench terraces and those without bench terraces.

Table 9: Correlations

			Do you have bench terraces on your land	Net return based on costs in two seasons
Spearman's rho	Do you have bench terraces on your land	Correlation Coefficient	1.000	-.453(**)
		Sig. (2-tailed)	.	.000
	Net return based on costs in two seasons	Correlation Coefficient	-.453(**)	1.000
		Sig. (2-tailed)	.000	.

** Correlation is significant at the 0.01 level (2-tailed).

a Listwise N = 64

The relationship between the uptake of bench terraces technology and the net returns attained from crop yields (r = -.453; p-value = .000) was average and negative. The negative correlation implies that an increase in the uptake of bench terraces technology is associated to a decrease in the net returns attained from crop yields. Among the farmers in the sub county who took up the bench terraces technology, there is a likelihood that their net returns attained from crop yields will not increase as expected. However, the significant value (p-value. < .01) indicates that the relationship between uptake of bench terraces and net returns attained from crop yields are linearly related.

Since (p-value < .01), the study rejected the null hypothesis that there is no relationship between the uptake of bench terraces technology and net returns attained from crop yields. Instead the study accepted the alternative hypothesis that there is a relationship between uptake of bench terraces technology and the net return attained from crop yields. Given a sample of 100% participants in the sub county, over 95% of them are likely to accept that the uptake of bench terraces technology is related to the net returns attained from crop yields.

The constraints/limitations of the study.

Language: Majority of the respondents (farmers) were used to the local dialect/language and this required translating the questions first to the local dialect/language. It was found to be time consuming, and spending more time with the respondent/interviewee and more still some of the respondents would not be fully comfortable to sit for long hours and respond to the administered questionnaires.

Nature of the terrain

The terrain of the study was hilly and in order to administer the questionnaires, it required movements from homesteads to homesteads crossing valleys and climbing hills, moving from farmer gardens to gardens for observations. In addition by nature of the terrain, majority of the farmer fields are fragmented and for purposes of getting the good information it would require reaching on all the sampled fields together with the respondents selected who would feel comfortable when their gardens are visited during the research study.

Funding the study

The funding of this study was self-centred. As a matter of fact, I have sponsored myself for the entire period while doing this Masters degree. It has become one of the challenging times and the greatest challenge encountered in the field while collecting data from the respondents where the they would expect some facilitation and which was inevitable because at the end of the day humanly speaking it would be hard to leave the respondent who would have given you her/his time responding to the questionnaire administered empty handed.

Discussion

Introduction

This chapter spells out the discussion of findings, conclusions, recommendations and areas for future research. The discussion of findings, conclusions and recommendations were presented according to study objectives.

Discussion of findings

The first objective estimated the crop yields of the common food crops; Irish potatoes and beans among farmers with and without bench terraces in Rubaya Sub county Kabale district. The study found that that farms with bench terraces had better crop yields than the farmers without bench terraces (for both beans and Irish potatoes)

This was reflected on the factor where 495 kg was registered as the mean annual yield among beans farmers who had bench terraces and 444 kg among farmers who did not have bench terraces. There was thus a slight margin and difference in yields of 51kgs. Therefore, beans yields were better among farmers who had bench terraces than those who did not have bench terraces. The results also showed that 4720 kg was the mean annual yield of Irish potatoes among farmers who used bench terraces and 506 kg among farmers who did not use bench terraces. Therefore, Irish potato yields were better among farmers with bench terraces than those who did not use bench terraces. It was thus observed that the crop yields from farms of the farmers using the bench terraces was higher than the crop yields from farms of the farmers without bench terraces for both crops respectively. This was attributed to the fact that the bench terraces hold better the soil nutrients and water for crop growth and development.

The research findings were thus in line with the former researchers like (Thomas , D.B et al 2011) [24] who noted that when the soil nutrients improve, then the crop yields are most likely related to increase since the crop will have benefited from the nutrients. This was more evidenced more practices like terracing was, in Uganda. Shiferaw et al (2009) [10], as well pointed that terracing land brings about the factor of combating land degradation where bench terracing controls soil erosion and this in the process gives way for crops grown in such terraced fields to gain from the soil nutrients which supports them for proper growth and producing better yields.

The second objective compared the net returns of the common food crops; Irish Potatoes and Beans among the farmers with and without bench terraces in Rubaya Sub county Kabale district. The study found that farmers' net returns from bench terraces outstrips farmers' net returns from farms that are not bench terraced (for both beans and Irish potatoes). The research findings indicated that, the minimum mean net returns from the Beans was 316,585 UGX registered among farmers without bench terraces in season 2020/2021 and the maximum mean net returns was 1,121,365 UGX registered among farmers with bench terraces in the season of 2019/2020 respectively.

Following the farmers who grew Irish potatoes, the minimum mean net returns from the sales among farmers with bench terraces was 1,995,144 UGX and the maximum was 2,660,203 UGX. The minimum mean net returns among the Irish potatoes farmers without bench terraces was 799,321 UGX and the maximum mean net returns was 893,600 UGX respectively.

Thus, the minimum mean net returns from Irish potatoes was 799,321 UGX registered among farmers without bench terraces in season 20219/2020, and the maximum mean net returns was 2,660,203 UGX registered among farmers with bench terraces in season 2020/2021 respectively. Following figures of Shillings got, the researcher concludes that farmers with bench terraces fetched more on their crop yields than those who were not using bench terraces. The researcher also observed that regardless of whether the farms were bench terraced or not, the net returns from Irish potatoes were significantly higher than the annual net returns from beans. On the whole, this research therefore, found out that farmers' net returns from bench terraces outstrip farmers' net returns from farms that are not bench terraced.

The research findings were thus in agreement with the previous research with reference made to FAO, (2018), where Irish potatoes are seen as the most important source of food, employment and income for the developing countries fetching more than other crops. And FAO report 2008 which spelt out that potatoes and beans had the potential to revive the incomes of the farmers with many getting more that 1 million shillings from the sales of the harvest season.

The third objective identified the perception of farmers on the uptake of bench terraces technology in Rubaya Sub County Kabale district. The study found out that lack of money, awareness, and attitude were the factors that majorly influence the uptake of bench terraces technology. The research findings indicated that farmers were not aware that bench terraces technology is to benefit smallholder farmers, particularly those with small pieces of land. They could not uptake bench terraces because they thought it requires large pieces of land. Farmers reported that their land was small and could not be taken up for bench terraces. The average acreage of land among the farmers investigated was about 0.45 acres. Most of the farmers, including those whose land is up for bench terracing have small land pieces of land. Therefore, there is some degree of unawareness that the said technology is to help small land acreage owners to obtain the most out of their small land. The findings further indicated that farmers perceptions were that bench terraces technology was very expensive. They were making conclusions perhaps without any assessment of what it required to uptake such a technology.

This finding was in line with (Thuo et al, 2014) [41], who noted that limited finance and access to capital for implementation and maintenance of sustainable land management technologies like bench terracing should be well considered. On the other hand, the decision to uptake a new or improved technology/practice could be regarded as an investment decision as pointed out by (Keeley, J., and Scoones, I., 2013) and therefore the attitude of the farmers was seen as a strong basis on whether the farmer uptake the bench terracing in the study area.

The fourth objective explored the strategies for increasing the uptake of bench terraces technology in Rubaya Sub county Kabale district. The research findings indicated that government support should be the major strategy towards increasing the uptake of bench terraces technology. The researcher found that most of the farmers who were using bench terraces had either used their own money or obtained external support from Kigezi Diocese water program. None of the farmers who were using bench terraces ever obtained funding from government. The government support was thus, four fold in sense that support would be in material or financial obligations, policy, partnership and extension services. This was on the basis that some other research reports had as well highlighted on the government as an organ that would spearhead the technologies.

The findings were thus in-line with what some of the previous researchers found out. This was pointed out by (Blanco, H and Lal, R, 2021) [4], where it was stated that a major portion of the land used for agriculture, particularly in ecologically fragile areas, is cultivated by small holder farmers who perform significant ecological services in the process. But for economic reasons these farmers need a multidimensional support ranging from policy, financial, and social-economic obligations.

Conclusion

There is a significant relationship between the uptake of bench terraces technology, the crop yields from potatoes and beans and net returns gained from crop sales in Rubaya Sub County.

Following research objectives, findings indicated that better crop yields were realized on farms which were bench terraced compared to the farms not terraced. While still the net returns from the crops on the terraced land were higher compared to the crops harvested from none terraced land in line with yields realized. The perceptions were however, hinged on the basis that bench terracing is an expensive venture and even though farmers have limited awareness and show a weak attitude on uptake, the government should holistically support the mechanisms ranging from policy, financial, and strengthen extension services. The researcher concludes that bench terraces should be embraced and promoted for better crop yields since it was evidenced by the research findings. The practical implication on this indicated that bench terraces should be promoted by development practitioners as a means of having degraded land rejuvenated into productive and arable land for agriculture.

Recommendations

There is need to include sustainable land management as a special package in the extension system for purposes of spearheading the technologies and practices in land improvement and management. And the government should ensure that bench terracing is promoted by considering putting in place the budgetary allocations in the sector of Agriculture in order to promote growing of common crops like potatoes and beans and realize better crop yields.

The recommendation of terracing land in line to producing high crop yields that would in the long run bring about high net returns from the sales of crops grown like Irish potatoes and beans should highly be recommended. This was observed because bench terracing leads to increased crop production and productivity which in the long run will as well increase on farmers' income.

The recommendation on objective of farmers perception should be that government should embrace supporting farmers to venture into terracing, because the farmers perception on the bench terracing mainly indicated limitations with the high investments attached to the bench terracing. The government should thus consider special packages in the extension system and look at putting in place demonstration sites where degraded landscapes would be terraced to convince farmers who would in the long run easily uptake the technologies.

The recommendation on policy formulation should be emphasized. The government and development agencies should have great concern of having special and guiding policies that govern the management of land in line to bench terracing and such policies should be well aligned with land and environment management act for purpose of ensuring that the farming communities are protected while harnessing and gaining from the agricultural domain.

Areas for future research

In regard to the findings of the study, further studies should be borne in mind for instance, Bench terraces for conservation Agriculture, the indigenous field practices for improved crop production.

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